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THE OCCURRENCE OF FLINT IN OHIO

By

WILBER STOUT, Geologist

and

R. A. SCHOENLAUB, Petrographer

GEOLOGICAL SURVEY OF OHIO
WILBER STOUT, STATE GEOLOGIST

FOURTH SERIES, BULLETIN 46

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Columbus
1945

F. J. Heer Printing Company
Columbus, O.
1946
Bound at State Bindery

ALLIED PRINTING
TRADES UNION LABEL COUNCIL
COLUMBUS

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INTRODUCTION

Most certainly the first native rock of the Ohio section to be selected for useful purposes was flint which was quarried and fashioned by primitive man into arrows, knives, skinners, drills, etc. For such needs, for ease in working, high quality material was necessary, or what is generally considered as true flint. On this account the main supplies were drawn from a few geological members and in rather limited fields. In Ohio the chief deposits for such work were the Vanport flint on Flint Ridge in Licking and Muskingum counties, Zaleski flint in Vinton and Jackson counties, and Upper Mercer flint in Hocking, Perry, and Coshocton counties. Other beds used by the aborigines to a less extent were Brush Creek flint in Lawrence, Gallia, and Athens counties, Brassfield and Bisher flints in Highland and Adams counties, and Delaware flint in Franklin, Delaware, and Marion counties. Such material in less quantity and with less quality occurs on other horizons in restricted or even in widely extended fields.

The pioneers, soon after settlement in the Ohio area, fashioned the rough porous flint from outcrop deposits into buhrstones to grind their grain in the old water mills. McArthur in Vinton County was noted for such a product. Here the industry was begun about 1807 and continued vigorously for over thirty years. The flint used was the Vanport. Another active field for buhrstones during this early period of development was Flint Ridge in Licking County where flint from the same member was utilized in this way. At present such material finds little employment except for minor purposes, such as decorating pools, rock gardens, walls, and chimneys.

OCCURRENCE OF FLINT IN OHIO

In this State flint or its more impure form, chert, occurs in a wide range of strata extending from the Brassfield limestone in the basal portion of the Silurian system to the Cambridge limestone in the lower half of the Conemaugh formation of the Pennsylvanian system. The formations in which it is now recognized are as follows:

System	*Group*	*Formation*	*Member*	*Remarks*
Pennsylvanian		Conemaugh	Cambridge	Flint local and small in amount
			Brush Creek	Flint common and often abundant
		Allegheny	Vanport	Flint common and often abundant
			Zaleski	Always flint or chert
			Putnam Hill	Flint local and small in amount
		Pottsville	Upper Mercer	Flint abundant often only material
			Lower Mercer	Flint rare and then local
			Boggs	Flint common but impure
Mississippian		Maxville		Flint local and small in quantity
Devonian		Delaware		Flint local but abundant
		Columbus		Flint common and abundant along certain zones
Silurian	Niagara	Cedarville-Guelph		Flint local and impure
		Bisher		Flint local but abundant
	Clinton	Brassfield		Flint confined largely to one zone, then local

CONDITIONS AND RELATIONSHIPS

Flint occurs under a variety of conditions and with differences in relationships. These are considered in a brief way.

1. In the rocks of Ohio the flint deposits are almost entirely associated with marine limestones and dolomites, largely the former. In this area no true flint is identified with limestones of fresh-water origin.

2. Not all marine formations contain flint but the exceptions are few. Likewise formations that contain flint in one area may be free from such material in parts or in most of the fields. No flint was observed in the Greenfield, Tymochtee, Put-in-Bay, and Raisin River formations of the Silurian system, in the Amherstburg and Lucas formations of the Devonian system, and in the Lowellville, Hamden, Ames, and Skelley limestones of the Pennsylvanian system.

3. In this State flint is far more abundant and is better in quality in the Pennsylvanian system than in the older divisions. In the coal formations the flint occurs in the marine limestones found directly or closely above the coal beds in the Pottsville, Allegheny, and Lower Conemaugh series. The normal position of the fresh-water limestones, without flint, is below the coal beds, that is, below the clay, generally thin, below the coal. The order of deposition, in the ascending scale, is fresh-water limestone without flint, clay, coal, marine limestone with flint, iron ore, and shale or sandstone.

4. In any specific stratum the flint may be very local or regional in extent. In Ohio good examples of the former are Putnam Hill and Cambridge in the Pennsylvanian system and of the latter Upper Mercer and Vanport in the same major division of rocks.

5. In the Pennsylvanian system the cycle of deposition was in the order a, b, c, d, and e.

(e) Shale and sandstone. Such deposits were derived from land areas and filled the basin, preparatory for the next cycle. Such cycles are repeated about every 40 feet throughout the coal formations.

(d) Iron ore. Such ores are carbonates in character. The iron compounds were held in suspension by organic acids from the coal forming agencies and were precipitated as ferrous carbonate on dilution by sea water. Such ores usually contain marine fossils.

(c) Limestone and flint. One or both materials were deposited through invasion of marine waters into the coal basins where the organic matter was yielding acid components.

(b) Coal. This rock was formed from organic matter of land plants growing under humid conditions and during a slight depression of the land surface.

(a) Clay. The underclays of the coal beds were purified largely by organic acids liberated in the decay of vegetable matter on land surfaces. The purification resulted in the loss of silica and bases such as iron oxides, alkalies, and alkaline earths. Alumina was increased and silica decreased in the process. The amount of silica removed from the clays in the soluble form was considerable and may easily approximate the flint in the limestones.

Diagrammatically these conditions may be represented as follows:

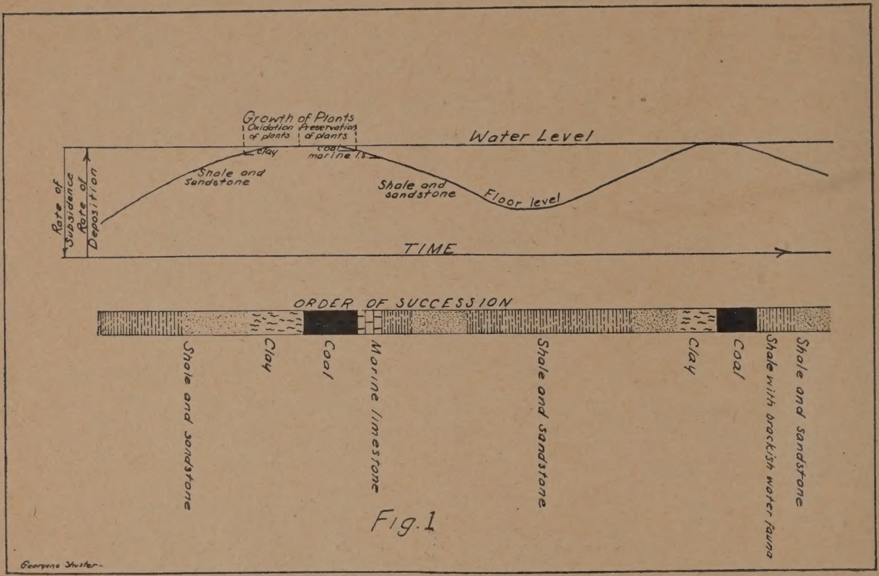
Growth of Plants
Oxidation of plants
Preservation of plants
Water Level
clay
coal
marine l.s.
Shale and Sandstone
Shale and sandstone
Floor level
Rate of Subsidence
Rate of Deposition
TIME
ORDER OF SUCCESSION
Shale and sandstone
Clay
Coal
Marine limestone
Shale and sandstone
Clay
Coal
Shale with brackish water fauna
Shale and sandstone
Georgene Shuster

Fig. 1

6. Flint may occur in several forms:

(a) As nodules from small to large size.

(b) As lenses usually irregular in outline.

(c) As sheet deposits making up the entire or a considerable part of the formation.

7. Flint is bedded in several ways:

(a) Small nodules widely scattered through the formation. These nodules, however widely apart, are spaced along definite zones or along certain bedding planes.

(b) Small nodules closely packed along a definite bedding plane. The nodules may or may not be continuous.

(c) Flint may occur in definite, irregular lenses interspaced in the limestone but on definite horizons.

(d) Flint may make up the entire formation or may be the dominant material on the horizon. In this State the Zaleski member is always a true flint or a cherty limestone. This is nearly true of the

Boggs member when not an iron ore. The Upper Mercer, Vanport, and Brush Creek members locally are entirely flint, usually of fair to good quality.

(e) Flint zones, lenses, stray nodules, etc., may be confined to a certain stratum in a formation. This is true in the Brassfield formation and in the Eversole member of the Columbus.

8: The appearance of flint in Ohio varies widely. Much of the flint in the coal formations is waxy in texture and gray to black in color. A variety of shades from clear, milky, pink, green, red, blue, and gray are found in the Flint Ridge area of Licking and Muskingum counties. The Devonian and Silurian flints are usually dull or earthy in luster and white or gray in color.

9: The color seems to result from the combined agencies of many substances present in small amounts. Iron compounds such as pyrite give gray, blues, or blacks; limonite gives browns and yellows; and hematite gives red or purple red. In the coal formation flints and, to a lesser extent in other flints, disseminated carbonaceous matter seems to give various shades of gray to black.

10: Some flints seem to be largely composed of fossils, whereas others are devoid of them. Usually the fossils appear incidental; that is, they have been occluded in the forming of the siliceous mass.

11: The most common impurities are calcium and magnesium carbonates, pyrites, argillaceous matter, and iron oxide. The carbonates and sulphides seem to be of chemical origin and to have grown to euhedral crystals in a gelatinous medium, whereas clay and other inert matter seem to have been occluded during formation.

12: True bedding-planes are usually absent in the purer types of flint but may be imperfectly marked in the cherty types.

13: The pyrite in some of the flints of Ohio suggests an organic influence in the deposition of the siliceous matter. The included pyrite is well crystallized and sharp in outline.

14: In all the nodular and lenticular deposits of flint there is a sharp delineation of flint and limestone. One does not gradate into the other.

15: Throughout most geologic time flint and the associated limestone were evidently deposited in shallow or comparatively shallow water. This is especially true in the Pennsylvanian system where the coal beds, deposited under land conditions, are repeated, on the average, about every 20 feet and where the marine limestones with or without flint were laid down every 50 feet. Cross-bedding, ripple marks, mud cracks, and desiccation brecciation also indicate relatively shallow seas for the deposition of the flint-bearing limestones and dolomites in the Mississippian, Devonian, and Silurian systems.

16. The contribution of soluble silica from the land areas to the sea has been continuous through the geological ages. Through the decay of rocks on land areas such minerals as feldspars, micas, etc., in passing to clays and other forms, yield much soluble silica. This is also true of the shale sediments that passed to coal formation clays in the Pennsylvanian system. In warm humid areas throughout geologic time lateritic action produced much soluble silica that passed to the sea. Thus the sea was constantly receiving small supplies of soluble silica.

ORIGIN

The origin of flint and its formation are imperfectly understood. As this origin is concerned with very dilute concentrations of an inert substance, the chemistry cannot be easily explained. It is, however, evident that enough silica has been available and that precipitating conditions have existed. Tarr describes the origin of flint as follows:[1] "The silica is taken into solution as a colloid by streams and carried to the sea. The amount thus removed, as will be shown, is greatest during periods of low-lying lands. This silica tends to accumulate in the sea under certain conditions, partly due to protective or hydrophilic sols, and finally is precipitated quite rapidly. The coagulated colloid, like all gels, tends to aggregate into more or less spherical, elliptical, or irregular masses upon the sea floor (more rarely spreading out as lenticular masses), and is buried by the accumulating calcareous muds. Rapid precipitation (probably due to supersaturation) and burial are indicated by the lack of calcareous material in the chert or flint. The weight of the overlying materials compresses the gel-mass, forcing it to assume a more or less elliptical shape, if large, but not altering the form if the mass is small. During burial, the nodules may continue to grow, slowly or rapidly, depending upon the amount of silica still present in the water. Nodes and other irregular growths will thus develop. Finally, complete burial cuts off any further growth. The rapid precipitation of the silica explains the universal occurrence of the chert or flint along a common plane or zone which may be independent of the bedding planes. Subsequent changes involve a loss of water and the contraction of the mass. The change of the gel to opal and then to chalcedony and quartz is a slow one. The older cherts are apparently more crystalline than the younger ones, and this is in keeping with what one would expect in the crystallization of a solid solution, such as the silica gel represents. Subsequent changes in the chert and flint have been essentially nil."

---

[1] Tarr, William Arthur, *The Origin of Chert and Flint,* The University of Missouri Studies, Vol. 1, Number 2, April 1, 1926, p. 24.

Observations of Ohio flints or cherts suggest a few minor supplementations to Tarr's description. Ohio cherts and flint seem to be contemporary in origin with the surrounding rocks with little material being subsequently added or removed. There seems to be a general resemblance between flints of a geological system and a closer resemblance between flints of a formation and member. This may imply a sensitivity of silica precipitates to chemical or physical environment. Contrary to Tarr's generalization, the newer flints in Ohio are the soundest and most crystalline, and many of the older flints are subject to weathering, are porous, and structurally weak.

DESCRIPTION

The essential constituent of flint is silica. The silica varies from 98 per cent or more in the purer grades to 60 per cent or less in the lowest grades. The silica is largely crypto-crystalline or amorphous. The combined water is usually less than 1 per cent. Common impurities are calcium and magnesium carbonates, pyrite, and argillaceous matter. Fossils may be absent or abundant. The chief coloring pigments are organic matter and iron compounds. Pyrite and organic matter seem to be the pigments in the gray and black cherts. The pinks, reds, greens, yellows, and browns in variegated forms in the Flint Ridge deposits seem to result largely from various compounds of iron. Except for the Flint Ridge deposits, the predominant shades of Ohio flints and cherts are grays and blacks.

As considered here, chert is only an impure or structurally imperfect flint. All gradations from one to the other are found, but in any one deposit, and to a decreasing extent, member, formation, and system the grades are similar. The classification of flints and cherts usually depends upon physical characteristics. The material is considered flint if it has a conchoidal fracture, a waxy luster, and is dense and weather resistant. If it has a dull or earthy luster, an indefinite fracture, a porous structure and a tendency, on weathering, to develop a white patina, it is considered chert. The classification of flints and cherts on a more scientific basis is desirable but difficult to accomplish.

SILURIAN SYSTEM

In Ohio flint in some quantity, large or small, is present at the surface in a thick section of strata ranging from the Brassfield limestone near the base of the Silurian system to the Ames limestone about the middle of the Conemaugh series of the Pennsylvanian system. In the Silurian system the formations with appreciable quantities of flint are Brassfield, Bisher, and Cedarville-Guelph. In general, these deposits are not outstanding and consist of stringers or nodules of flint bedded in the limestone or dolomite. Further, the material is commonly poor in quality, that is, it is what is usually called chert. The deposits will be described in a general way.

BRASSFIELD MEMBER

The trend of the outcrop of the Brassfield limestone in Ohio is northeastward from the Indiana-Ohio line near Fairhaven across Preble and Montgomery counties into central Miami County, thence southeastward across Clark, Greene, Clinton, Highland, and Adams counties to the Ohio River near Rome. The thickness of the member is from 20 to 60 feet with an average around 30 feet. The Brassfield member is of marine origin and classed as a limestone, although the lower portion is magnesian in character. In stratification it varies from thin to massive beds. Locally flint, or more correctly chert, appears in the lower part of the formation in a few feet of section. The flinty phase is best developed in Adams and Highland counties.

"The Brassfield limestone is well exposed along the north side of Route 52, near the home of Treber Johnson, on the point of the hill west of the mouth of Ohio Brush Creek, in southeastern Monroe Township, Adams County. The section follows:[1]

"Brassfield formation	*Ft.*	*In.*
Limestone, light, hard, fossiliferous	..	5
Limestone, light, hard, fossiliferous	..	6
Shale, calcareous, gray	..	1
Limestone, light, hard, fossiliferous	..	4
Shale, calcareous, gray	..	2
Limestone, light, dense	..	6
Shale, calcareous, gray	..	3
Limestone, massive, hard, uniformly bedded	1	1
Shale, calcareous, gray	..	4
Limestone, light, hard	..	5
Shale, with thin irregular layers of limestone	..	11
Limestone, light, hard	..	5
Shale, calcareous, gray	..	3
Limestone, part pink, ferruginous, oolitic	1	11
Limestone, light, hard	..	9
Shale, calcareous, gray	..	2
Limestone, light, hard	..	3
Shale, calcareous, gray	..	5
Limestone, light, hard	..	11
Shale, calcareous, gray	..	2
Limestone, hard, gray	..	4
Limestone, hard, gray	..	5
Shale, calcareous, gray	..	8
Limestone, massive, with much chert	6	2
Limestone and shale, thin layers alternating	7	0
Limestone, shaly, drab, massive	2	4

---

[1] Geol. Survey Ohio, Fourth Series, Bull. 42, pp. 47-48.

Elkhorn formation		
Shale, bluish gray to pink, with thin shaly layers of limestone	12	0
Road level, elevation 545 feet approximately.”		

A section farther to the north in Adams County is also given: “The Brassfield limestone is well exposed in the road cut, west side of road, on Route 41, just south of the bridge over Ohio Brush Creek, one mile southwest of Jacksonville, western Meigs Township, Adams County. The rock section is given below:[1]

“Brassfield formation	*Ft.*	*In.*
Limestone, light, medium to massive layers, with only thin partings	5	10
Shale, calcareous, with a few layers of limestone, 2 to 6 inches in thickness	5	2
Shale, calcareous, with widely spaced layers of limestone, 2 to 6 inches in thickness	9	10
Limestone, thin to massive layers with shale partings (top layer very ferruginous)	10	2
Shale, bluish gray, with thin limestones	1	7
Limestone, thin to massive layers, hard, very fossiliferous, some thin shale partings	12	0
Limestone, massive, with much chert, fossiliferous	4	4
Limestone, thin to medium bedded with shale partings	6	2
Shale, calcareous, with thin layers of limestone	6	0
Limestone, shaly, drab to bluish gray, hard, a few fossils	3	6
Shale, calcareous, bluish gray	3	4
Limestone, very shaly, bluish gray	2	2
Shale, calcareous, gray	..	8
Elkhorn formation		
Shale, calcareous, pinkish, with thin layers of shaly limestone	7	0
Road level.”		

The Brassfield limestone is well exposed at many places in western Adams County, especially along Ohio Brush Creek and its tributaries and farther west along the headwaters of Eagle Creek. The outcrop is rather conspicuously marked by weathered blocks of flint, usually light in color, and porous in texture. The fresh flint found along the stream beds is impure or of the cherty character. Such material was easily available to the tribes that built the great earthworks in the region but its low quality made it unattractive.

The Brassfield member outcrops in wide areas in Concord, Jackson, and Washington townships, Highland County, and is present in smaller areas in Liberty, Market, Union, and Hamer townships. Throughout this field also one stratum contains much chert and another is decidedly ferruginous. In general, however, the deposits are less siliceous in Highland County than they are in Adams County. A representative section follows:

---

[1] Geol. Survey Ohio, Fourth Series, Bull. 42, pp. 49-50.

"Along a small western tributary of Ohio Brush Creek, one and one-quarter miles east of Folsom in south central Washington Township, Highland County, the Brassfield limestone was exposed for measurement:[1]

"Brassfield formation	Ft.	In.
Limestone, pink, hematite	..	10
Limestone, coarse, gray, crystalline, crinoidal	1	0
Limestone, bluish gray, medium crystalline	..	9
Clay shale, greenish	1	4
Covered	2	0
Limestone, bluish gray, fine texture	2	0
Covered	1	0
Limestone, light blue, finely crystalline	..	10
Limestone, light blue, coarsely crystalline, very fossiliferous	1	6
Covered	..	6
Limestone, bluish gray, finely crystalline	..	7
Covered	2	0
Limestone, yellowish gray, crinoidal	..	11
Limestone, light gray, finely crystalline	4	0
Limestone, bluish gray, more or less laminated	5	6
Limestone, bluish gray, with occasional chert lenses	3	6
Limestone gray, coarsely crystalline, with corals, irregularly bedded, much jointed	2	6
Limestone, gray, crystalline, laminated	..	6
Limestone, bluish gray, crystalline, crinoidal	1	1
Limestone, blue, heavy-bedded, crystalline	1	1
Limestone, blue, thin bedded	..	6
Belfast formation		
Shale, calcareous, soft, bluish gray, with limy beds up to 1 inch in thickness	3	0"

To the northwest and west of Highland County in Clinton, Greene, Clark, Miami, Montgomery, and Preble counties the flint in the Brassfield limestone becomes inconspicuous or absent. Where present it is little more than small nodules of chert.

BISHER-WEST UNION FORMATION

The lower part of the Niagara series in Ohio differs much from the middle and upper portions and also changes in character in its horizontal extension. This rather distinctive division is known in Adams County as the West Union member, in Highland County as the Lilley-Bisher, and in Clark County as the Springfield. It is a dolomite varying much in structure, texture, bedding, and purity. Thin flint layers, part of good quality, are present particularly in the vicinity of Hillsboro and of the great Serpent Mound. Only a few sections need be given.

---

[1] Geol. Survey Ohio, Fourth Series, Bull. 42, pp. 76-77.

"The quarry and crusher of Carey Brothers are located on Milford Road at the western edge of Hillsboro in Liberty Township, Highland County. The section follows:[1]

	Ft.	*In.*
Soil and shelly dolomite	2	0
Niagara Series		
Lilley formation		
Dolomite, bluish gray, massive layers, hard, fossiliferous	16	0
Bisher formation		
Dolomite, bluish gray, massive, hard, with thin, widely spaced layers of impure flint, fossiliferous	17	0
Floor of quarry.		

"The flint layers alone were sampled in 1936 by R. A. Schoenlaub of the State Highway Department. Analyst, Downs Schaaf.

Silica, SiO_2	95.11
Alumina, Al_2O_3	0.14
Ferric oxide, Fe_2O_3	0.40
Ferrous oxide, FeO	0.44
Pyrite, FeS_2	0.21
Magnesium oxide, MgO	0.71
Calcium oxide, CaO	1.11
Sodium oxide, Na_2O	<0.01
Potassium oxide, K_2O	0.01
Water, hydroscopic, H_2O-	0.43
Water, combined, H_2O+	0.25
Carbon dioxide, CO_2	1.38
Titanic oxide, TiO_2	0.03
Phosphorus pentoxide, P_2O_5	0.01
Sulphur trioxide, SO_3	<0.01
Manganous oxide, MnO	0.01
Zinc oxide, ZnO	<0.01
Carbon, organic, C	0.05
Hydrogen, organic, H	<0.01
Total	100.29

A photomicrograph of the Bisher chert by R. A. Schoenlaub of the State Highway Testing Laboratory (1937) follows:

Another section taken in Highland County near the Bates School follows: "The Bisher formation is exposed along a small tributary of Clear Creek, east of Bates School, three and three-fourths miles northeast of Hillsboro in Liberty Township, Highland County. The strata were sectioned and sampled by J. R. Rogers in 1930. The record follows:[2]

---

[1] Geol. Survey Ohio, Fourth Series, Bull. 42, pp. 79-80.
[2] Idem., pp. 82-3.

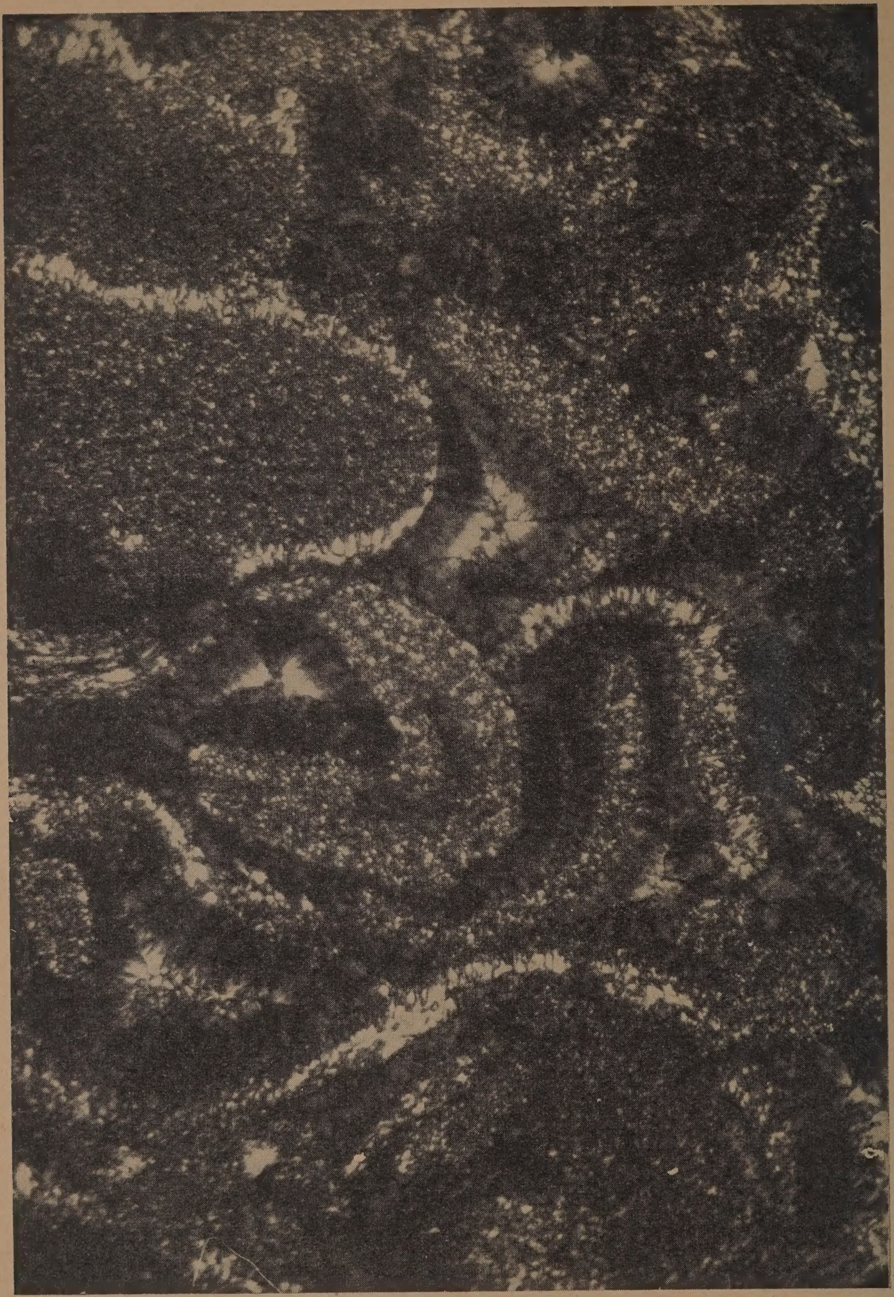

PLATE I

Photomicrograph of Bisher Chert

This photograph of chert from the Carey Brothers Quarry at Hillsboro shows a characteristic structure. While the fossils are varied, the general characteristics of the chert are constant. In the photograph all of he substance is siliceous, often however, parts are composed of carbonates or glauconite. Magnification 100 diameters. Crossed nicols.

	Ft.	In.
Niagara Series		
Base of Lilley formation		
Bisher formation		
Covered	2	0
Dolomite, brown	1	0
Covered	2	0
Dolomite, yellowish brown	4	0
Dolomite, yellowish brown, very cherty	1	6
Dolomite, hard, some chert and geodes	2	0
Dolomite, shaly	1	0
Covered	6	0
Dolomite, very cherty	1	6
Covered	2	0
Dolomite, with some chert	2	0
Covered	1	0
Dolomite, fractured	1	2
Dolomite, very cherty, beds 2 to 4 inches	1	6
Dolomite, weathered, parts covered	11	0
Dolomite, brown, thin-bedded	3	0
Dolomite, brown to gray	1	6
Covered	4	6
Dolomite, bluish, crystalline	2	0
Total thickness	50	8

"The sample for chemical analysis was taken from the exposed beds. The results obtained are given below: Analyst, Downs Schaaf.

Silica, SiO_2	24.92
Alumina, Al_2O_3	1.82
Ferric oxide, Fe_2O_3	0.66
Ferrous oxide, FeO	0.40
Pyrite, FeS_2	0.16
Magnesium oxide, MgO	14.70
Calcium oxide, CaO	22.32
Strontium oxide, SrO	None
Barium oxide, BaO	None
Sodium oxide, Na_2O	0.03
Potassium oxide, K_2O	0.04
Water, hydroscopic, H_2O-	0.36
Water, combined, H_2O+	0.42
Carbon dioxide, CO_2	33.82
Titanic oxide, TiO_2	0.18
Phosphorus pentoxide, P_2O_5	0.10
Sulphur trioxide, SO_3	<0.01
Manganous oxide, MnO	0.11
Carbon, organic, C	0.08
Total	100.12

The total silica shown in the analysis, 24.92 per cent, and the free silica indicated in a mineral analysis, 22.79 per cent, indicate the relative quantity of flint in the Bisher formation. This flint is of fair quality and was used by primitive man for various implements as shown by many found within the region. These are usually rather dark in color and often banded. The flint was probably gathered along the stream beds where the material was unweathered and solid.

The Bisher formation extends eastward into western Adams County but in general contains less flint except in the Serpent Mound area. At Peebles the flint is confined to a zone about 5 feet in thickness and, in general, the material is nodular in form, light gray in color, and cherty in composition.

CEDARVILLE-GUELPH FORMATION

In the Niagara series of rocks the Cedarville-Guelph formation is, in general, a very pure dolomite and is widely distributed throughout western Ohio. The mean thickness is around 150 feet. In local areas flinty phases are developed in a few feet of rock in the middle portion. This flint, however, is of poor or cherty quality, unfit for the fashioning of implements. On this account it will be given little attention.

"The Niagara dolomite was worked, 1940, for road material by the Highway Department of Greene County. The quarry is located one and three-fourths miles west of Jamestown on headwaters of Caesar Creek, south of the old Myers School in the northwestern part of Silver Creek Township, Greene County. The section is given below:[1]

"Niagara formation	*Ft.*	*In.*
Dolomite, blocky, medium bedded, much stained and weathered, buff to drab color	3	0
Shale, calcareous, gray to drab	..	3
Dolomite, bluish gray to buff to brownish, upper part considerably weathered, coarse texture	14	0
Dolomite, massive, hard, open to close texture, parts with small openings or vugs, gray to bluish gray, locally carbon stained, some fossils, local patch in west end of quarry with many chert nodules	21	0

Floor, dolomite."

Somewhat similar conditions were observed in west central Ohio in Hardin County. Here the flint or free silica made up over 4 per cent of the rock mass in a section of 21 feet. The record follows: "The quarry and lime calcination plant of the Herzog Lime and Stone Company are located at McVitty, one and one-half miles southwest of Forest, just east of the Big Four Railroad, in the southwestern part of the southwest quarter of Section 19, Jackson Township, Hardin County. The section of the rocks exposed is given below:[1]

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[1] Geol. Survey Ohio, Fourth Series, Bull. 42, p. 154.

	Ft.	In.
"Drift	2	0
Monroe formation		
Dolomite, thin to medium bedded, layers from ½ to 6 inches, weathered slightly, buff to brownish color	12	0
Niagara formation		
Dolomite, light to bluish gray, massive structure, banded somewhat by organic stains, open crystalline texture, few fossils.	56	0
Dolomite, dark gray, banded with organic pigments, with nodular flint in lenticular layers	21	0
Floor of deep part of quarry."		

DEVONIAN SYSTEM

In Ohio the rocks of the Devonian system are all of marine origin and include dolomites, limestones, flints, shales, and sandstones. They outcrop in wide areas in the central and northern portions of the State, are of great economic importance, and average between 700 and 800 feet in thickness. The system is divided into eight formations with a number of members. Flint is a common constituent in both the Columbus and Delaware formations.

COLUMBUS FORMATION

The Columbus formation outcrops in a broad belt from 10 to 25 miles in width and nearly 150 miles in length. This field extends from Pickaway County on the south through western Franklin, eastern Union, western Delaware, eastern Marion, eastern Wyandot, western Crawford, eastern Seneca, southeastern Sandusky, and western Erie County to Kelleys Island in Lake Erie. The second field, much covered by drift, is a crescent-shaped area in northwestern Ohio on the west flank of the Cincinnati arch or on the rim of the Michigan Basin. It extends from northern Paulding County through southeastern Defiance, northwestern Putnam, central Henry, and northwestern Wood to western Lucas County. The thickness of the formation varies from 80 to 125 feet.

In general, the upper part of the Columbus formation is limestone of high purity and quite free from chert. This division is from 50 to 60 feet in thickness. The lower part, from 35 to 45 feet, is a limy dolomite, brown in color, and more or less charged with flint or chert nodules, usually not large in size. In part of the field the upper part of the dolomite division is called the Eversole member. This is from 8 to 12 feet in thickness and is conspicuous for the abundance of chert scattered indiscriminately through the mass and placed in rather definite layers. The flint nodules are light in color, cherty or impure in character, and generally small in size. Such material was unfit for fashioning implements and probably was not used by primitive man. A few sections will suffice to show the geology of the flint deposits.

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[1] Geol. Survey Ohio, Fourth Series, Bull. 42, p. 270.

"The Columbus formation is well exposed at the O'Shaughnessy dam located on the Scioto River, one mile north of the Delaware-Franklin County line in the southwestern corner of Delaware County. The section follows:[1]

"Columbus formation	*Ft.*	*In.*
Klondike member		
Limestone, weathered slightly, gray to drab, hard, dense, some layers chalky, fossiliferous......................	22	0
Limestone, hard, dense, gray to drab, very fossiliferous, corals, brachiopods, cephalopods, etc..................	23	7
Eversole chert		
Dolomite, brown, medium to massive layers, with chert nodules, scattered and in layers, some fossils............	10	1
Bellepoint member		
Dolomite, massive layers, brown color, grainy, fine crystalline texture, some fossils..................................	14	4
Water level in basin below dam."		

In the Eversole member of the above section the chert or free silica makes up about 8.81 per cent of the whole and in the Bellepoint member ony 1.46 per cent. Where weathered along the outcrop the flint nodules appear as light chalky masses with hard siliceous cores. Similar flinty phases of the Columbus formation are found elsewhere in Franklin, Delaware, and Marion counties.

In the Bellefontaine outlier of Logan and north central Champaign counties the upper or limestone part of the Columbus formation is absent, thus leaving only the lower or dolomite phase. Much chert is shown in all the sections. The following is representative of the conditions:

"The quarry and crushing plant of the East Liberty Stone Company are located north of Otter Creek and the Toledo and Ohio Central Railroad, on the main road, Route 32, one and one-fourth miles west of East Liberty in the southwestern part of Perry Township, Logan County. The section is given below:[2]

"Columbus formation	*Ft.*	*In.*
Dolomite, buff, thin to massive, layers broken by weathering, contains scattered nodules of chert....................	13	0
Dolomite, light, massive, rather dense, contains scattered nodules of chert..	4	2

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[1] Geol. Survey Ohio, Fourth Series, Bull. 42, p. 223.

[1] Idem., p. 255.

Dolomite, irregular, light	..	3
Chert, irregular, limy	..	3
Dolomite, with some chert	1	5
Chert, irregular	..	1
Dolomite, variable	..	6
Chert, irregular	..	1
Dolomite, with a few nodules of chert	1	3
Chert, irregular	..	1
Dolomite, light	..	5
Dolomite, buff, with a few chert nodules	1	3
Dolomite, buff, irregular	2	4
Dolomite, light, massive, with little or no chert	7	10

Floor of quarry, more stone below."

The dolomite in the upper portion of this section contains 1.74 per cent chert or free silica, that in the middle portion 5.15 per cent, and that in the lower portion 4.02 per cent.

In general, in north central Ohio in Wyandot, Crawford, Seneca, Sandusky, and Erie counties the quantity of chert or impure flint in the Columbus formation is not large and is confined to zones, usually only a few feet in thickness. The following section is representative:

"In the North Side quarry on Kelleys Island the following section is exposed:[1]

"Columbus limestone	*Ft.*	*In.*
Thin bedded fossiliferous gray limestone	10	8
Very fossiliferous gray limestone somewhat more massive than the layers above	7	6
A massive layer of gray to brown limestone. It sometimes shows one or two minor bedding planes but is usually one layer	7	8
Brown limestone with rather soft gray to white chert intermixed	3	9
Brown limestone with no chert	1	0
Thin grayish brown shaly parting	..	3
Massive brown limestone with some chert in three discontinuous layers	4	3
Massive brown limestone somewhat banded and in one or two beds	14	6
Very fossiliferous brown to grayish brown limestone	4	0
Monroe dolomite		
Brown dolomite	1	0

In northwest Ohio on the flank of the Michigan basin in Lucas, Wood, Henry, Defiance, and Paulding counties the Columbus formation is from 40 to 60 feet in thickness, and consists largely of the lower or dolomite portion. In general the deposits are more or less cherty and locally decidedly so in certain zones. The following section shows the usual condition:

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[1] Geol. Survey Ohio, Fourth Series, Bull. 10, p. 139.

"The works of the Pugh Quarry Company, at Custer, is located three and one-fourth miles northwest of Milton Center, four and one-half miles southwest of Weston, in the southwest corner of Section 6, Milton Township, Wood County. The record follows: [1]

"Columbus formation	*Ft.*	*In.*
Dolomite, light to drab, grainy, massive, rather dense, weathered some, few fossils	2	9
Dolomite, dark brown, grainy, with some fossils, massive, with a few irregular chert nodules at top and others near bottom	7	9
Dolomite, massive, brown, grainy, sugary texture, few fossils	8	6
Floor of quarry."		

To the north of this in Lucas County the Columbus formation is usually rather free from the cherty impurities. Along certain zones, however, nodules of flint appear widely spaced through the mass or locally concentrated along bedding planes. The section given below and taken at Whitehouse shows this condition:

"Traverse formation	*Ft.*	*In.*
Rather compact crystalline gray limestone	..	6
Compact finely crystalline gray limestone	..	10
Gray to bluish gray limestone, compact and crystalline	2	0
Compact blue to brown limestone	1	6
Very fossiliferous blue to gray limestone	1	0
Columbus formation		
Thin uneven bedded bluish gray limestone	9	3
Bluish gray limestone, in 3 to 6-inch layers	1	10
Light bluish gray limestone in 6 to 14-inch layers	3	8
Massive bluish gray limestone containing pockets of fossiliferous white chert	3	0
Massive bluish brown crystalline limestone weathering blue	2	0"[2]

A sample of chert from this quarry was examined, 1936, by R. A. Schoenlaub of the State Highway Testing Laboratory. The photomicrograph is shown in Plate II.

DELAWARE FORMATION

The Delaware formation is present in two areas in Ohio. The main field is in the central part of the State in a long narrow belt extending from western Pickaway County northward past Columbus, Delaware, Marion, and Bellevue to Sandusky on Lake Erie. The other area is in

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[1] Geol. Survey, Ohio, Fourth Series, Bull. 42, pp. 395-396.

[2] Geol. Survey, Ohio, Fourth Series, Bull. 10, pp. 149-150.

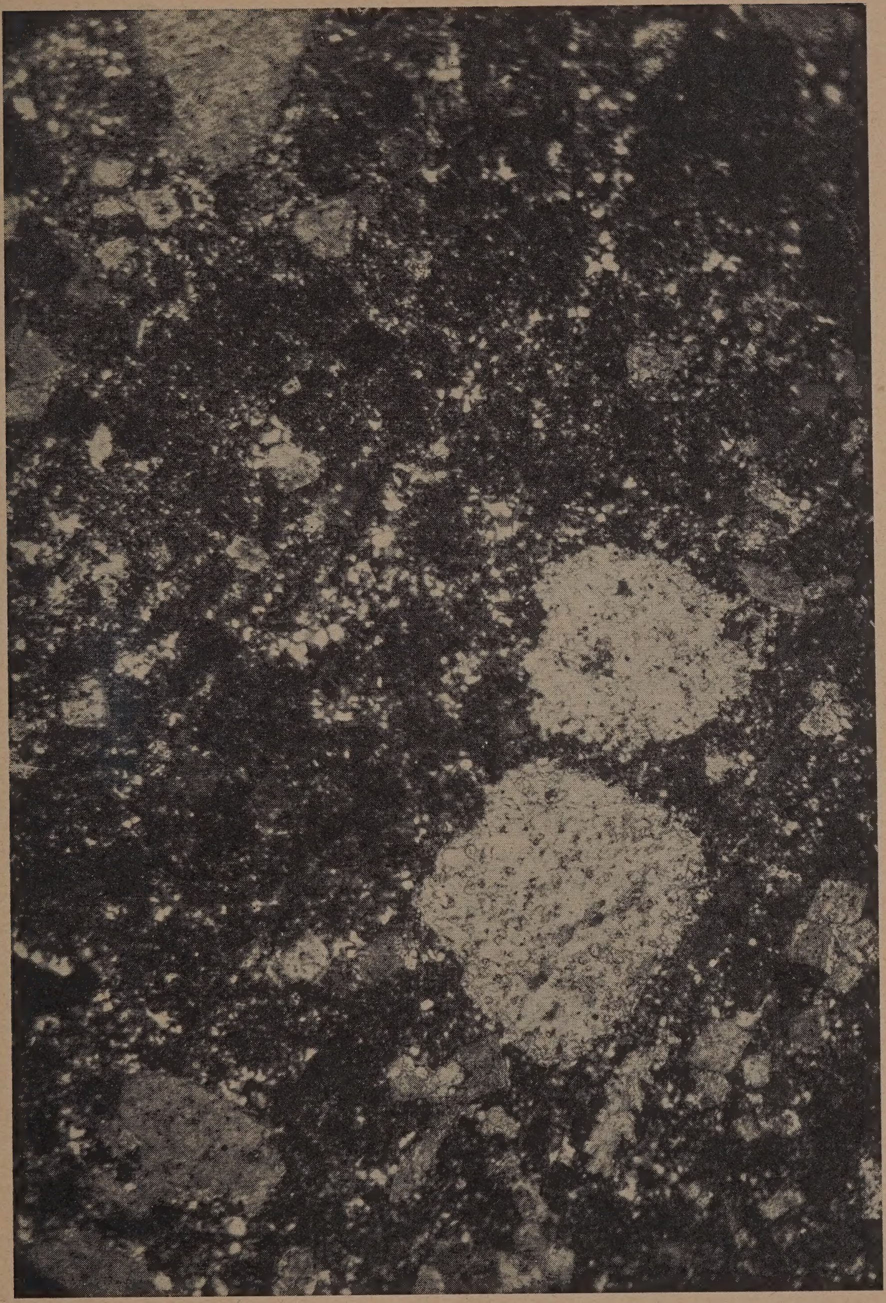

PLATE II

Photomicrograph of Chert, Columbus Formation

This photograph of chert from the Whitehouse Quarry at Whitehouse shows a texture representative of the poorer grades of Devonian chert. The matrix is composed of isotropic silica with a small amount of anisotropic silica visible through the ground mass as small white specks. The large irregular masses of calcite suggest the occlusion of clastic matter. The smaller rhombohedrons of calcite suggest the subsequent formation in a permeable and elastic medium. Compare this to Plate III. Magnification 100 diameters. Crossed nicols. N-93.

northwestern Ohio in western Lucas, northwestern Wood, central Henry, southern Defiance, and northern Paulding counties. Here the deposits have been called Traverse and are equivalent in time to the Delaware and the Olentangy of central Ohio. This formation is wanting in the Bellefontaine outlier in Logan County. The formation ranges from 30 to 70 feet in thickness and averages close to 45 feet. It varies in character from shales with only thin limestone layers to rather massive limestones with only bedding plane partings of shaly matter. Chert or impure flint is common throughout the entire range of the Delaware formation. Scattered sections are given to show the presence of the flint.

In Franklin County the main exposures of the Delaware beds are along the bluffs of the Scioto River from Columbus northward to the Franklin-Delaware county line. The formation varies from 25 to 45 feet in thickness but averages usually between 30 and 35 feet. It is made up of thin layers of hard limestone, of calcareous shale as parting material, and of flint or chert either in bands or in nodules with or without bedding planes. The following section which is representative was measured at the Marble Cliff quarry on the east side of the Scioto River:

	Ft.	*In.*
“Delaware limestone		
Rather thin bedded bluish brown limestone containing some chert in the upper part and all much weathered........	5	0
Thin bedded bluish limestone containing a large amount of black chert in layers..................................	5	10
Massive bluish limestone with much black chert intermixed. The upper part is often more or less concretionary in appearance	3	8
Shaly and rather thick layers of bluish brown limestone containing much black chert..............................	5	0
Soft thin bedded grayish brown shale with some chert......	..	6
Columbus formation		
Limestone in numerous layers................................	36	4”[1]

In this area the chert or free silica is about 21 per cent of the total. The flint is dark in color, brownish black to black. It occurs in nodules and in stringers, some up to 2 or 3 inches in thickness.

The type locality for the Delaware limestone is at Delaware in Delaware County. The main exposures are along the Olentangy River and on bluffs east of the Scioto River. The formation varies from 30 to a maximum of about 45 feet in thickness. Chert is a common impurity.

“The quarry and crusher of the Kuenzli Quarries Company at Delaware are located in the southern part of the city west of the Olentangy River and east of the Oak Grove Cemetery. The section follows:[2]

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[1] Geol. Survey Ohio, Fourth Series, Bull. 10, page 48.

[2] Geol. Survey Ohio, Fourth Series, Bull. 42, pp. 234-235.

"Delaware formation	*Ft.*	*In.*
Limestone, dark blue, no flint, splits in layers 2 to 3 inches in thickness	3	6
Limestone, three layers, dark bluish gray, with some nodules of white chert	1	9
Limestone, same as above, no chert	2	0
Limestone, brownish, laminated, shaly	..	3
Limestone, bluish gray, with scattered nodules of chert	2	6
Chert and cherty limestone	..	2
Limestone, bluish gray, with an occasional nodule of black chert	2	8
Chert, black	..	3
Limestone, bluish gray, three layers, no chert	2	0
Limestone, cherty	..	8
Limestone, bluish gray, massive, practically no chert	3	0
Limestone, bluish gray, small nodules of chert, same color as limestone	4	0

Base of pit about 7 feet above level of Olentangy River.

"The chemical composition of the 22 feet 9 inches of Delaware limestone at the Kuenzli quarry is given below. Analyst Downs Schaaf.

Silica, SiO_2	7.40
Alumina, Al_2O_3	1.45
Ferric oxide, Fe_2O_3	0.75
Ferrous oxide, FeO	0.30
Pyrite, FeS_2	0.15
Magnesium oxide, MgO	9.08
Calcium oxide, CaO	38.86
Strontium oxide, SrO	None
Barium oxide, BaO	<0.01
Sodium oxide, Na_2O	0.05
Potassium oxide, K_2O	0.06
Water, hydroscopic, H_2O-	0.20
Water, combined, H_2O+	0.44
Carbon dioxide, CO_2	40.20
Titanic oxide, TiO_2	0.07
Phosphorus pentoxide, P_2O_5	0.32
Sulphur trioxide, SO_3	0.05
Manganous oxide, MnO	0.06
Vanadium oxide, V_2O_5	<0.01
Carbon, organic, C	0.63
Hydrogen, organic, H	0.09
Total	100.16"

From calculation the relative quantity of free silica as chert is close to 5.29 per cent. "In order to determine something of the nature of the flint or chert in the Delaware limestone, two samples were taken, one of nodular chert and another of pyritiferous chert, by R. A. Schoenlaub of the State Highway Department, June 22, 1936. The analyses follow. Analyst, Downs Schaaf.[1]

	"*Nodular chert*	*Pyritiferous chert*
Silica, SiO_2	70.78	95.92
Alumina, Al_2O_3	0.45	0.25
Ferric oxide, Fe_2O_3	0.02	0.03
Ferrous oxide, FeO	0.30	0.81
Pyrite, FeS_2	0.27	0.35
Magnesium oxide, MgO	1.88	0.19
Calcium oxide, CaO	12.90	0.50
Sodium oxide, Na_2O	0.05	0.04
Potassium oxide, K_2O	0.06	0.05
Water, hydroscopic, H_2O-	0.32	0.43
Water, combined, H_2O+	0.48	0.70
Carbon dioxide, CO_2	12.04	0.49
Titanic oxide, TiO_2	0.03	0.02
Phosphorus pentoxide, P_2O_5	0.16	0.05
Sulphur trioxide, SO_3	<0.01	<0.01
Manganous oxide, MnO	0.02	<0.01
Zirconium oxide, ZrO_2	<0.01	<0.01
Carbon, organic, C	0.33	0.29
Hydrogen, organic, H	0.05	0.04
Total	100.14	100.16"

A photomicrograph of the flint from the Kuenzli Quarry at Delaware was made (1936) by R. A. Schoenlaub of the State Highway Testing Laboratory and is given below:

The Delaware limestone extends in a narrow belt from two to five miles in width northward through Waldo, Pleasant, Richland, Marion, Claridon, Prairie, and Scott townships. No accurate measurements of the entire formation are available but the thickness as calculated from various data is approximately 40 feet. It is rather regularly bedded, the layers ranging from 1 inch to 2 feet in thickness but commonly measuring from 4 to 12 inches. Chert is a common constituent. The siliceous matter may be deposited in scattered nodules or in irregular lenticular layers along bedding planes.

The following section is representative: "In the old Evans quarry of the France Stone Company, located about two miles northwest of the center of Marion, east of the Hocking Valley Railroad, in the east-central part of Section 17, Marion Township, Marion County, the Delaware limestone is well exposed. The section follows:[2]

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[1] Geol. Survey Ohio, Fourth Series, Bull. 42, pp. 236-237.
[2] Idem., p. 288

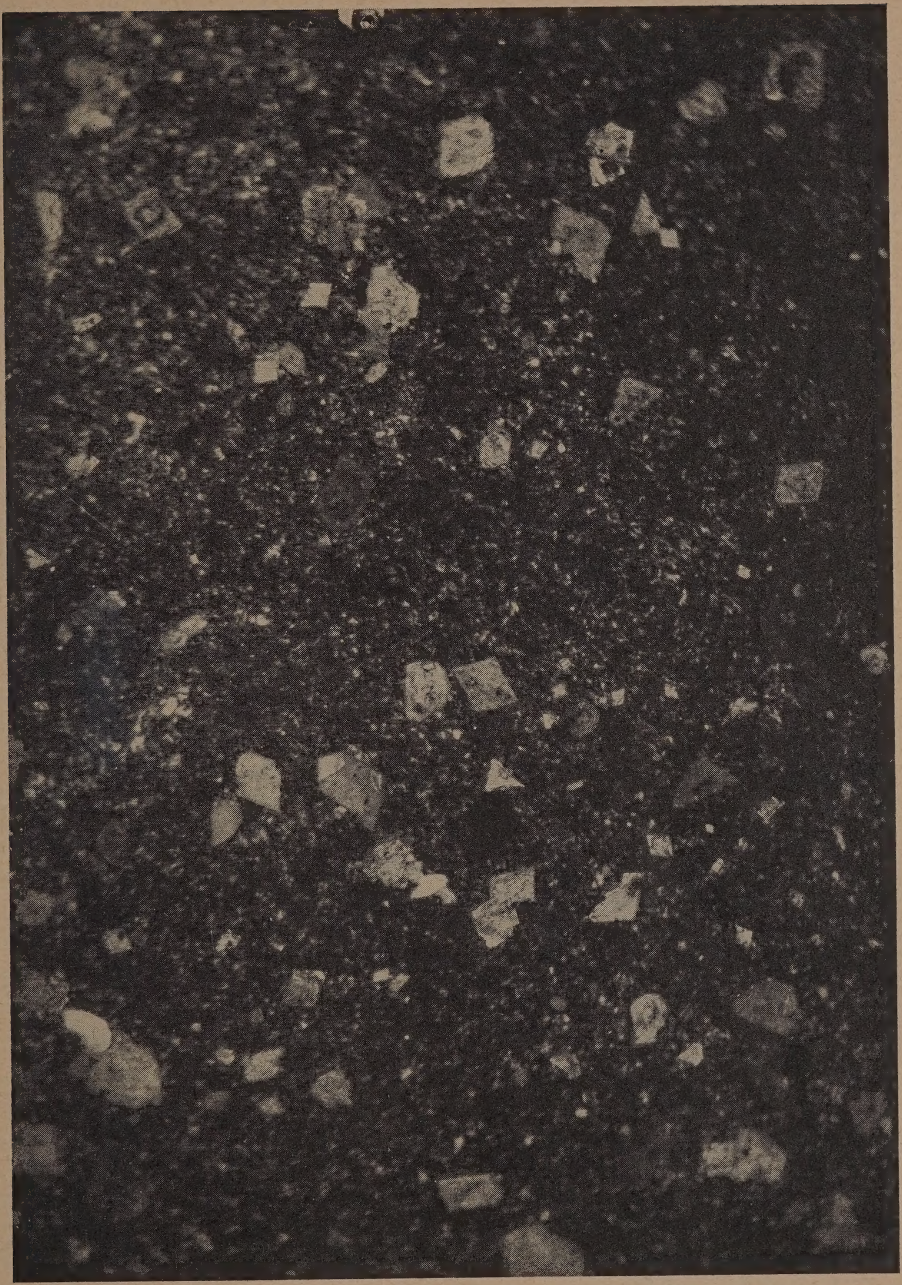

PLATE III

Photomicrograph of Devonian Chert

This photograph of chert from the Kuenzli Quarry at Delaware shows the characteristic structure representative of the better grades of Devonian chert. The matrix is largely isotropic with minor amounts of anisotropic silica visible in the photograph as white specks. Most of the calcite is in small crystalline rhombohedrons, occasionally there as irregular masses of calcite. The similarity in structure between this material and that shown in Plate II, despite the distance of about 100 miles between their outcrops, is notable. Magnification 100 diameters. Crossed nicols.

"Delaware formation	*Ft.*	*In.*
Limestone, bluish, with nodules and nodular layers of chert..	11	8
Chert, nodular, and cherty limestone	..	6
Limestone, blue, with layers and nodules of chert, layers 5 inches to 1 foot 4 inches thick	7	10
Limestone, tough, blue	1	2
Limestone, blue, thin chert at top	2	0
Limestone, blue, massive	2	0
Columbus formation		
Limestone, gray, fossiliferous, bone bed at top	4	0
Limestone, gray, massive	10	0
Covered rubble."		

The flint content in three quarries in this county are 6.66, 8.53, and 4.31 per cent. The flint is dark in color and varies from quite cherty to rather pure.

The Delaware formation extends in a narrow belt from three to five miles in width across western Crawford County through Dallas, Bucyrus, Holmes, and Lykens townships. With few exceptions the exposures are poor and are confined to areas where the streams have cut through the mantle of drift. In the few localities where observed the deposits appear to be normal, that is, made up of thin to medium bedded limestones with more or less chert in nodules and stringers.

The most eastern formation of carbonate rock in Seneca County is the Delaware which crosses the area in a northeast-southwest direction in a belt from four to five miles in width. The townships covered include eastern Bloom, northwestern Venice, southeastern Scipio, western and central Reed, and southeastern Thompson. Such rocks are exposed at numerous places in Thompson and Bloom townships. The stone is thin to medium bedded, hard and tough, light to dark blue, and very fossiliferous. Some layers contain considerable chert, part in the nodular form.

The stratigraphic condition of the formation is well represented by the section given below: "The Bloomville quarry of the France Stone Company is located in the central part of the northeast quarter of Section 11, Bloom Township, Seneca County. The section follows:[1]

"Delaware formation	*Ft.*	*In.*
Limestone, light, thin-bedded, no chert	4	0
Limestone, bluish, with light colored chert, even bedded layers 3 to 4 inches thick. Chert occurs in branching masses in limestone layers. Nodules of chert rare and distinct, layers wanting...	16	8
Limestone, light, blue, crinoidal, layers 3 to 10 inches thick..	3	6
Limestone, shaly	..	1

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[1] Geol. Survey Ohio, Fourth Series, Bull. 42, p. 356.

Limestone, dark blue	..	5
Limestone, shaly	..	1
Limestone, dark blue	..	5
Limestone, dark blue	..	10
Columbus formation		
Limestone, crystalline, fossiliferous	4	8"

The stone in the upper part of the formation—the 16 foot 8 inch layers—is very siliceous in character showing on analysis 23.50 per cent silica, SiO_2, and by calculation 21.81 per cent free silica as chert. The lower part—5 feet 4 inches—is much less siliceous, only 3.50 per cent free silica as chert.

From Seneca County the Delaware limestone extends northward across northwestern Huron County and western Erie County to the lake and bay near Sandusky. The stone is well bedded, finely crystalline, hard, dense, and fossiliferous. Locally it contains chert, usually in the nodular form, localized along bedding planes and varying much in color depending on the state of weathering.

The stone was best exposed, when visited, in the quarry described below: "The pit of the Wagner Quarries Company is located south of the State Soldiers Home, in Perkins Township, Erie County. The section follows:

"Delaware formation	*Ft.*	*In.*
Limestone, brownish gray, dense, layers 3 inches to 1 foot in thickness, no chert	10	6
Limestone, brownish gray, dense, thin layers	4	10
Limestone, chocolate brown, finely laminated, lower part with pyrite	3	6
Limestone, chocolate brown, fossiliferous, dense, one layer laminated, with pyrite, 2 inch layer of chert 1 foot 2 inches from bottom	6	2
Limestone, chocolate brown, dense, with one stringer of chert nodules near the middle	2	0
Limestone, massive, becoming more crystalline downwards and of a more grayish blue cast	5	6
Limestone, grayish blue, more crystalline than that above, fossiliferous	2	0
Floor of west end of pit."[1]		

As a whole these deposits are not especially siliceous as much of the strata is free from such matter. Here the 34 feet 6 inches of stone showed 5.63 per cent silica, SiO_2, by analysis and 3.08 per cent of chert by calculation.

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[1] Geol. Survey Ohio, Fourth Series, Bull. 42, p. 366.

The Traverse formation of northwestern Ohio, consisting of the Delaware limestone and Olentangy shale, and outcropping in Lucas, Wood, Henry, and Defiance counties, locally bears some flint. One of the best exposed sections is along Ten Mile Creek just south of the quarries at Silica. The record is given below:

“Traverse formation	*Ft.*	*In.*
Massive bluish drab limestone containing iron pyrite, traces of petroleum, and a few fossils	10	0
Thin unevenly bedded blue limestone with several layers of white chert	3	0
Blue shale and soft shaly blue limestone containing much iron pyrite	2	6
Bluish gray limestone alternating with layers of fossiliferous white chert	3	6
A rather compact drab limestone with many fossils, occurring as casts, and much fossiliferous white chert	2	0
Bluish gray shaly limestone with irregular layers of fossiliferous white chert	2	0
Blue limestone interbedded with soft blue shaly layers	4	0
Covered interval	20	0
Columbus formation”[1]		

Thus a general survey of the Delaware formation across the State reveals that the deposits carry considerable flint varying in quality from very impure to quite clean material. The beds are well exposed at many places along the streams and much loose flint is found in the rubble deposits. Hence primitive man was favored with collecting grounds. Some of the dark and dark gray flints are of the best quality. These are amorphous in character and break with a sharp conchoidal fracture. Most of the nodular and also the stringer flint has a white coating on the outside. Along the outcrop the Delaware flint is much broken by fractures which eventually reduces the larger blocks to smaller pieces The flint from the Delaware formation found some employment for the rougher types of implements.

MISSISSIPPIAN SYSTEM

In general the aggregate thickness of the rocks of the Mississippian system is from 500 to 800 feet. In northeastern Ohio they are much below this figure. The great variation is due to the outstanding disconformity of the top of the group. In the main the rocks consist of siliceous shales and impure sandstones, generally the former kind predominating. The only calcareous formation in the system is the Maxville limestone, the youngest member of the series. This limestone, however, is very

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[1] Geol. Survey Ohio, Fourth Series, Bull. 10, pp. 145-146.

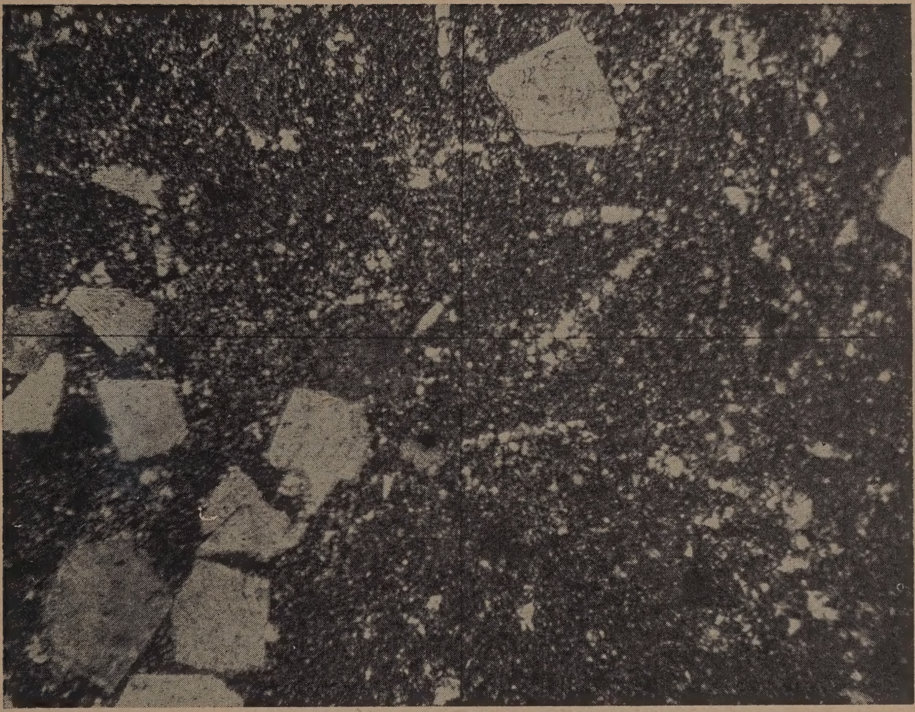

PLATE IV

Photomicrograph of Mississippian Flint

This flint is from Harrison County, Indiana. It has a matrix of isotropic silica and a somewhat larger proportion of anisotropic silica than was the case in the Devonian cherts. Some of the silica is in spicular forms. The carbonate is present as large euhedral rhombohedrons. There are a few grains of pyrite, which are not shown. Magnification 100 diameters. Crossed nicols. Sample 4.

patchy in development, being present only in local areas and there not often with good thickness. It bears only small quantities of flint or chert.

MAXVILLE LIMESTONE

The rocks of the Maxville formation are the youngest in the Mississippian system and lie just below the base of the Pottsville rocks of the Pennsylvanian system. The Maxville limestones were laid down on the sandstones and shales of the Logan formation, then were cut away from the top during a long cycle of erosion, which action left only small isolated areas that stand out like islands in the ocean. Such deposits are present at the surface in Scioto, Jackson, Vinton, Hocking, Perry, and Muskingum counties.

In general the Maxville limestone is free from flint or chert in any form. "On the Jesse Weimer farm, near the head of Munn Run, in Section 26, Clay Township, Scioto County, is found a small pocket of limestone which is also represented by scattered nodules of flint and limestone on two high hills just southwest of his property. Also in Section 22, on the property of Ernest Cline, both the Sciotoville clay and Maxville limestone were seen on the outcrop. The thickness of the limestone, which is flinty in character, was not obtained."[1]

In the larger deposits in Perry and Muskingum counties only an exceptional nodule of flint is present. These deposits offered primitive man little or nothing for flint for arrow making.

EROSION INTERVAL

A long and intensive period of erosion prevailed after the Mississippian rocks were laid down and before the Pennsylvanian strata were deposited. Thus much strata, but in varying amounts, were lost from the upper portion of the Mississippian deposits and some beds are absent from the basal portion of the Pennsylvanian system. The only deposit that may be assigned to this long erosion period is the Harrison ore member.

HARRISON ORE

The Harrison member, named for deposits near Harrison Furnace in Scioto County, is found along the erosion interval between the Mississippian and the Pennsylvanian rocks. It is not conformable with either of these. Its composition is variable. In places it is composed of a brecciated mass of siliceous fragments cemented by iron compounds. The siliceous material appears to be what was once pieces of flint that through long weathering and solution have been changed to grainy silica. Quartz pebbles are a common component.

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[1] Geol. Survey Ohio, Fourth Series, Bull. 20, p. 477.

As it offers nothing in the way of good flint but as it may lead to confusion by the scattered pieces along the outcrop, a few sections will be given: "On Munn Hill, in Section 32, Clay Township, Scioto County, is shown the following section:

Pottsville series, Pennsylvanian system	*Ft.*	*In.*
Sandstone, shaly	20	0
Coal, bony, *Anthony*	..	6
Clay, flint, *Sciotoville*	3	6
Shales, parts covered	38	0
Erosion interval		
Conglomerate zone, of flint, boulders, shale, and ferruginous clay, *Harrison* ore	2	0
Logan formation, Mississippian system, shales and sandstones	100	0"[1]

In the southwestern part of Section 20, Richland Township, Vinton County, the Harrison member is conspicuous. It occurs at an elevation of 770 feet. The section taken is given below:

Pottsville series, Pennsylvanian system	*Ft.*	*In.*
Sandstone, soft, cross-bedded	8	0
Erosion interval		
Conglomerate, flint boulders, sand, and quartz pebbles bonded with iron ore, *Harrison* ore	..	8
Logan formation, Mississippian system		
Sandstone	3	0[2]

"The following section is typical of some of the thicker exposures of the Harrison ore in Coshocton County. It was taken along the east-west road, in the south central portion of Section 5, Jefferson Township, Coshocton County.

Pottsville series, Pennsylvanian system	*Ft.*	*In.*
Limestone, dark, *Lower Mercer*	1	0
Coal smut, *Middle Mercer*	..	1
Clay	1	0
Covered	33	5
Sandstone and covered intervals	37	0
Sandstone, ferruginous, micaceous	5	10
Shale, sandy, micaceous	10	0
Erosion interval		
Sandstone, massive, very ferruginous with white chert nodules up to 4½ inches, also ore nodules up to 5 inches, *Harrison*	1	2
Logan formation, Mississippian system		
Sandstone	16	0"[3]

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[1] Geol. Survey Ohio, Fourth Series, Bull. 20, p. 482.

[2] See note book sections 572 and 632, Vinton County, W. Stout.

[3] Thesis, "The Geology of Jefferson and Bedford Townships, Coshocton County," by Theodore Ralph Meyers, 1929, p. 23.

The Harrison member is also present in northeastern Ohio in many places, in Holmes, Wayne, Summit, Geauga, and Trumbull counties. However, it is represented more by iron ore than by chert.

PENNSYLVANIAN SYSTEM

In Ohio the rocks of the Pennsylvanian system cover an area approximating 12,340 square miles and have a mean thickness not far from 1,116 feet. They consist of shales, sandstones, clays, coals, limestones, iron ores, and flints in cyclic succession. The system is divided into four series, Pottsville, Allegheny, Conemaugh, and Monongahela, which are sub-divided into members. The marine limestones bearing flint range from the basal portion of the Pottsville series to the middle portion of the Conemaugh. Above this the limestones are entirely fresh water in origin and bear no flint or chert. The members bearing appreciable or large amounts of flint are Boggs, Upper Mercer, Zaleski, Vanport, and Brush Creek.

BOGGS MEMBER

The Boggs member was named by Orton in 1884 from iron ore deposits on the Boggs farm near South Webster in Scioto County. This horizon is intermittently marked by ore deposits elsewhere in southern Ohio and by ore, limestone, or flint in central Ohio. The limestone and flint phases are most evident in Perry, Licking, Muskingum, Coshocton, and Tuscarawas counties. Normally the position of the member is about 25 feet below the Lower Mercer limestone and 3 feet above the Lower Mercer coal of the Pottsville series of the Pennsylvanian system.

The flinty phase of the Boggs member first appears in northern Perry County. The record given below was taken east of Glenford, in Section 10, Hopewell Township, Perry County:

	Ft.	*In.*
Limestone, shaly, *Lower Mercer*..............................	10	0
Shales and covered..	30	0
Flint, dark, *Boggs*..	..	4
Shale, siliceous..	2	8
Coal and black shale, *Lower Mercer*..........................	1	0

This member assumes its maximum development and most persistent continuity in Muskingum County where it is best exhibited in Hopewell, Falls, Muskingum, Cass, and Jackson townships and is also represented in some force in Newton, Licking, Jefferson, Madison, and Washington townships. The Boggs horizon in Muskingum County may be marked by limestone, flint, iron ore, or almost any combination of these rocks. The flint is usually highly colored with iron oxide and carbon, the colors varying from nearly white through grays to black, the latter shade prevailing. Here the Boggs member lies at most only a few feet above the Lower Mercer coal and on the average 22 feet below the Lower Mercer limestone.

In order to show the geology of the member a few sections are given below: On the property of Dela Wise and others in Section 18, Hopewell Township, Muskingum County, the following composite section was taken:

		Ft.	*In.*
Shale, gray, with scattered ore nodules		4	4
Flint, black, *Upper Mercer*		..	9
Shale, gray, siliceous		..	3
Coal, cannel nature, *Bedford*		1	6
Clay, light, siliceous		3	0
Clay shale		3	0
Coal, fair, *Upper Mercer*		..	6
Clay, light, siliceous		2	6
Sandstone, shaly		4	0
Covered		4	0
Limestone, blue, fossiliferous	*Lower Mercer*	..	8
Limestone, blue, fossiliferous		1	8
Clay, light, siliceous, *Middle Mercer*		3	0
Shales and shaly sandstone		5	0
Clay, flint, dark	*Flint Ridge*	1	4
Clay, light, siliceous		5	8
Covered		5	0
Ore, Kidney, fossiliferous	*Boggs*	..	3
Flint, dark, fossiliferous		..	4
Sandstone, hard, dark, ferruginous		..	3
Clay, shaly, *Lower Mercer* coal horizon		2	0
Sandstone, shaly		5	0
Shales and covered		19	0
Shale, gray		7	0
Shale, dark, very fossiliferous with limestone nodules	*Poverty Run* or *Lowellville*	1	0
Limestone, blocky, fossiliferous		..	3

Along the road and in a west tributary of Bartlett Run, near the Falls-Muskingum township line, in the northwestern part of Falls Township, Muskingum County, the following rocks were exposed for measurement:

		Ft.	*In.*
Sandstone, massive, replaces the *Upper Mercer* limestone		41	0
Shale, dark		1	0
Limestone, dark blue, hard, fossiliferous	*Lower Mercer*	..	4
Shale, calcareous, fossiliferous		..	2
Limestone, gray, hard, fossiliferous		1	0

Shale, dark		..	4
Coal, cannel, hard, bony	*Middle Mercer*	..	6
Coal, bony, hard		..	8
Clay, siliceous, light		1	0
Sandstone, very irregular		3	0
Shale, siliceous		4	0
Coal, bony	*Flint Ridge*	..	4
Shale, dark, with thin coal bands		..	8
Clay, siliceous, light		3	0
Covered		5	0
Ore, siliceous, siderite	*Boggs*	1	2
Flint, black, calcareous		1	6
Shale, siliceous		2	0
Coal, hard, cannel nature, *Lower Mercer*		..	8
Clay, light, siliceous		3	0

In this locality the Boggs member varies from 1 to 3 feet in thickness and from a cherty limestone to a rather pure dark colored flint. On the headwaters of Beech Run northwest of Ellis in northeastern Muskingum Township, Muskingum County, most of the strata in the Upper Pottsville series were well exposed. The record secured is given below:

		Ft.	*In.*
Limestone, gray, hard, *Putnam Hill*		4	4
Shale, dark		..	1
Coal, fair, *Brookville*		..	11
Clay and covered		4	6
Sandstone, shale, gray		10	0
Shales, dark		8	0
Clay, light, *Tionesta*		2	0
Shale, siliceous		3	0
Limestone, dark, blocky, with black flint nodules, varies from 1 to 3 feet, *Upper Mercer*		2	0
Shale, dark		..	8
Coal, hard	*Bedford*	..	4
Shale, bony		..	2
Coal, hard, bony		..	6
Shale and bone coal		..	4
Coal, good		..	6
Clay and covered		1	6
Sandstone, shaly		11	0
Limestone, blue, shaly, fossiliferous	*Lower Mercer*	..	6
Limestone, blue, hard, fossiliferous		..	7
Limestone, blue, shaly, fossiliferous		..	5
Limestone, bluish gray, hard, fossiliferous		2	6
Shale, dark		..	4
Coal, bony, *Middle Mercer*		..	9
Clay and clay-bonded sandstone		3	6

Shales, part sandy	11	0
Limestone, dark, flinty, fossiliferous, *Boggs*	1	1
Clay shale, siliceous	3	4

North of Muskingum County in Coshocton, Holmes, Wayne, and Tuscarawas counties the Boggs member, if present, is usually a limestone or an iron ore. The flinty phase is seldom present. In Stark, Summit, Mahoning, and Trumbull counties the member is much impoverished, not often more than a nodular ore. Thus the field of the flint on the Boggs horizon is limited to central Ohio and there only locally is flint of good quality present. Its use by primitive man at most would be local.

LOWER MERCER LIMESTONE MEMBER

The Lower Mercer limestone is a very persistent bed across Ohio. The stratum enters Ohio from Pennsylvania in Mahoning County where it is well represented along the Mahoning Valley. From here the member extends southward through Portage, Stark, Summit, Wayne, Tuscarawas, Holmes, Coshocton, Muskingum, Licking, Perry, Hocking, Vinton, Jackson, Scioto, and Lawrence counties into Kentucky. The member commonly is a hard blue limestone with more or less calcareous, fossiliferous shale. Flint even in small nodules is unusual as a replacement rock. The only well developed flint observed on the horizon is in a very local area in Vinton County.

"At the sharp turn of the ridge road in southeastern Section 20, Jackson Township, Vinton County, the lower stratum of the Lower Mercer member consists of dark limestone with large masses of black flint. The thickness of the bed is about 1 foot and its elevation nearly 1,010 feet."[1]

UPPER MERCER LIMESTONE MEMBER

The Upper Mercer member, represented in some form, extends with only local wants across the State from Columbiana and Mahoning counties on the east to Scioto and Lawrence counties on the Ohio River. In the northern part of the field in Columbiana, Mahoning, Stark, Wayne, Tuscarawas, and Holmes counties, the horizon is marked by a hard, blue limestone with or without flint nodules. Locally here, however, the deposits are so flinty that the quantity of siliceous matter in them is greater than that of the calcareous component. In its extension southward into the central part of the State in Coshocton, Muskingum, Licking, Perry, and Hocking counties, the common material at this position in the geological column is a black flint, overlain occasionally with irregular lenses of gray flint or with thin deposits of iron ore. In southern Ohio in Vinton, Jackson, Scioto, and Lawrence counties, this stratigraphic unit is represented by iron ore with little or no flint or limestone. In general, the Upper Mercer member where traced across the State thus changes from hard, blue limestone to black flint and then to iron ore.

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[1] Geol. Survey Ohio, Fourth Series, Bull. 31, p. 125.

In the main the flint appearing on this horizon is usually dark or even coal-black in color, due to the influence of carbon and other pigments. The purer material is vitreous, brittle, and lustrous, and breaks with a deep conchoidal fracture in any direction. It is very dense and solid, except for small irregular cavities distributed indiscriminately throughout the mass. Like the limestone, the flint bed is regularly divided by joint planes into blocks which, where exposed along the outcrop, are more or less shattered by a network of fine cracks caused by expansion changes. The Upper Mercer flint is similar in appearance to the Zaleski flint, except that the latter is freer from cavities, slightly deeper brown in color, and more resinous in luster. The stratigraphic position of the Upper Mercer member is, regionally, 48 feet below the Putnam Hill limestone, 105 feet below the Vanport limestone, 34 feet above the Lower Mercer limestone, and 53 feet above the Boggs member.

Scioto, Lawrence, Jackson, and Vinton Counties

In Scioto, Lawrence, and Jackson counties the Upper Mercer is represented by iron ore with occasional lenses of limestone and a few scattered nodules of flint. Ore predominates in Vinton County but both flint and limestone are not uncommon. Along the abandoned road in north central Section 1, Richland Township, Vinton County the following beds were exposed:

	Ft.	*In.*
Ore, blocky, *Upper Mercer*	..	3
Shale, siliceous	..	4
Flint, gray to black, *Upper Mercer*	..	7

The geology of the member is shown in the following record taken along the road in the northwestern part of Section 36, Jackson Township, Vinton County:

	Ft.	*In.*
Shale, dark, siliceous	9	0
Coal, weathered, *Clarion*	3	0
Clay, dark	1	0
Clay, plastic, light	5	0
Shale and covered	4	0
Coal blossom, poorly exposed, *Winters*	..	6
Clay shale, and covered	15	6
Flint, black, *Zaleski*	..	10
Covered	3	2
Coal blossom, slumped, *Ogan*	1	0
Covered	9	0

Coal, weathered, *Brookville or Newland*	1	0
Clay, plastic, light	2	6
Shale and covered	26	6
Ore, blocky, *Upper Mercer*	..	4
Flint, gray, fossiliferous, *Upper Mercer*	..	4
Shale, gray, siliceous	12	6
Coal, shaly, *Upper Mercer*	..	10

At this place the flint varies in thickness from 1 to 6 inches with an average of about 4 inches. In Swan Township, flint is commonly present on the Upper Mercer horizon. The quality of the material is generally good. The following beds were exposed along an old road in the southeastern part of Section 9, Swan Township, Vinton County:

	Ft.	*In.*
Ore, blocky, weathered, *Upper Mercer*	..	2
Flint, gray to dark, siliceous, fossiliferous, varies from 4 to 8 inches, *Upper Mercer*	..	6

Hocking County

Throughout Hocking County the Upper Mercer member is commonly represented by black flint of excellent quality. The thickness varies from a few inches to over 3 feet. The best deposits show clear lustrous material in massive structure and well fitted for the manufacture of implements by primitive man. Representative deposits will be described.

In eastern Benton Township black flint of the Upper Mercer member is locally present along the high ridges and knobs. The record given below was obtained along the road near the forks in the southeastern part of Section 24, Benton Township, Hocking County:

		Ft.	*In.*
Flint, black, blocky, *Upper Mercer*, elevation 1,071 feet		..	5
Covered		5	10
Coal smut, *Bedford*		..	2
Clay, siliceous		1	0
Shales and shaly sandstones		3	4
Covered		12	9
Ore, blocky	*Lower Mercer*	..	2
Shale, siliceous		..	1
Ore, nodular		..	1
Shale, gray		..	11
Shale, gray, fossiliferous, *Lower Mercer* limestone horizon		..	7
Clay, light, siliceous		3	5

The geology of the Upper Mercer member is exceptionally well shown, as well as the three phases, ore, limestone, and flint, in the record given below and measured in a gully on the knob, southeast of the road, in the southwestern part of Section 31, Washington Township, Hocking County:

		Ft.	*In.*
Top of knob, elevation 1,045 feet		..	..
Shales, gray		18	0
Shale, calcareous, very fossiliferous, *Putnam Hill*		1	8
Shale, dark, carbonaceous, place of *Brookville* coal		1	1
Clay, dark		2	0
Shale, gray		3	4
Shale, black		..	1
Coal, fair		..	1
Clay, light		1	6
Shale, gray		6	4
Coal, shaly	*Tionesta*	..	8
Shale, coaly		..	8
Coal, shaly		1	0
Clay, light, siliceous		3	4
Shale and shaly sandstone		7	0
Ore, kidney	*Upper Mercer*	..	3
Sandstone, shaly		..	3
Ore, blocky		..	5
Ore, shelly		..	7
Limestone, blue, fossiliferous	*Upper Mercer* elevation 995 ft.	..	9
Shale, siliceous		..	11
Flint, black, good		..	5
Shale, siliceous		7	8
Coal, fair	*Bedford*	..	3
Sandstone, shaly		..	2
Shale, coaly		..	5
Clay, light, siliceous		1	6
Sandstone, shaly		6	4
Shale, dark, *Upper Mercer* coal horizon		..	6
Clay, light, siliceous		2	6
Shale, gray, siliceous		6	0
Ore, blocky, *Lower Mercer*		..	2
Shale, gray		..	8
Shale, dark, place of *Middle Mercer* coal		..	6
Sandstone, hard, dark		..	2
Clay, light, siliceous		2	7
Shale, dark		..	4
Sandstone, hard, dark, ganister, place of *Flint Ridge* coal		..	3
Shale, dark		..	3
Clay, light, plastic		3	0
Shale, gray, part siliceous		15	2
Shale, dark		..	5
Coal, hard, *Lower Mercer*		1	8
Clay, light, plastic		1	0
Shale, gray, part covered		4	4
Shale, dark, siliceous		..	10
Shale, gray, siliceous		2	0
Sandstone, massive, *Massillon*		25	0

Deposits of the Upper Mercer limestone member are present but generally not well developed in the southeastern part of Falls Township. This is true also in northern Starr Township. However, in Green Township, the member has excellent continuity and the flint phase is well represented, both as to the thickness of the stratum and as to the quality of the material. In order to show various geological conditions a few sections from this area will be given.

On the T. H. Davis farm, one mile west of Greenland School, two and one-half miles southwest of Kachelmacher, in central Green Township, Hocking County, the following beds were exposed for measurement:

		Ft.	*In.*
Flint, black, solid, irregular	*Upper Mercer* (elevation 816 ft.)	1	1
Flint, black, vitreous, irregular		4	6
Shale, black, with thin coal bands		..	11
Coal, good	*Bedford*	..	5
Clay, impure		..	3
Coal, good		2	6
Shale, black, carbonaceous		..	3
Clay, plastic, siliceous		2	0
Covered		8	0
Shale, much weathered, fossiliferous, *Lower Mercer*		1	0
Shale, dark		..	8
Coal, weathered, *Middle Mercer*		..	6

Flint from this vicinity was quarried by the aborigines as much evidence still remains of their workmanship. This flint is of high quality, being massive, dense, and vitreous. In mass it is jet black.

In the hollow in the east central part of Section 23, Green Township, Hocking County, the Upper Mercer deposits are well developed and show both flint and limestone. The section obtained follows:

		Ft.	*In.*
Flint, black, massive, solid, two layers	*Upper Mercer*	3	2
Limestone, hard, fossiliferous		..	11
Limestone, shaly, fossiliferous		..	9
Coal, not well exposed, *Bedford*		1	0
Covered		18	4
Limestone, shaly, fossiliferous	*Lower Mercer*	..	4
Shale, gray, fossiliferous		..	6
Limestone, blue, hard, fossiliferous		..	2

Some of the higher geological strata are shown in the record given below and taken in the hollow west of Monday Creek, just west of power plant (abandoned) at Greendale, three-fourths of a mile northwest of Kachelmacher, in northeastern Green Township, Hocking County:

	Ft.	*In.*
Shale, gray	25	0
Limestone, shaly, bluish, very fossiliferous, *Putnam Hill*	1	7
Coal, blocky, good, *Brookville*	..	5
Clay, dark, with ganister	1	8
Coal, bony	..	2
Clay, dark *Tionesta*	..	10
Coal, bony	1	3
Clay, dark, good	1	6
Clay, light, siliceous, good	3	6
Shale, blue to gray	7	6
Ore, blocky, irregular, *Upper Mercer*	..	3
Flint, black, varies from 10 inches to 2 feet, *Upper Mercer*	1	2
Coal, bony, irregular, *Bedford*	..	4
Clay, light, plastic	3	0
Sandstone, massive	9	0

In Green Township, the Upper Mercer ore is only locally present; the flint is usually there but changes erratically from a few inches to several feet in thickness; and the limestone occurs in local lenses, usually bedded below the flint. This area offers good collecting for black flint on the Upper Mercer horizon.

In general the flint is not so well developed in Falls-Gore Township, Hocking County. Locally the bed is replaced by sandstone. Where observed the deposits are generally thin, 1 foot or less in thickness.

Perry County

The Upper Mercer strata are generally well marked across Perry County, being found in force in Monday Creek, Salt Lick, Pike, and Clayton townships. The member may be represented by flint, dark and gray, thin to thick, by limestone with flint nodules, by iron ore, and by combinations of flint, ore, and limestone. Locally the deposits have exceptional thickness and were worked by primitive man. A few of the more characteristic deposits will be described by sections.

"Both flint and limestone are shown in the record given below and taken near the head of Coalbrook Hollow in Section 4, Monday Creek Township, Perry County:

	Ft.	*In.*
"Shale, ferruginous, fossiliferous, *Putnam Hill*	..	4
Coal, *Brookville*	..	6
Clay, light, plastic	4	8
Clay shale	3	0
Sandstone, irregular	..	6
Shale, blue, argillaceous	2	8
Sandstone, irregular	..	3
Shale, gray	1	4

Shale, dark		1	4
Coal, *Tionesta*		1	0
Clay, plastic		3	6
Covered		4	2
Flint, black, irregular	*Upper Mercer*	..	4
Limestone, blue, with large irregular masses of black flint		1	8"[1]

The Upper Mercer limestone and flint are exposed not far above drainage in the western part of Salt Lick Township. The deposits show much variability from place to place. Locally the beds are well developed. This is especially true in a ravine east of the road in the east central part of Section 18, Salt Lick Township, Perry County, where the following beds were exposed along the stream:

		Ft.	*In.*
Sandstone, massive		10	0
Covered		3	0
Flint, black, hard		..	5
Limestone, gray, fossiliferous	*Upper Mercer*	..	3
Flint, black, irregular		..	6
Limestone, gray, fossiliferous		..	8
Shale, dark, fossiliferous		..	8
Limestone, dark, fossiliferous		..	4
Shale, dark, siliceous, hard		..	10
Covered		3	0
Sandstone, irregular		1	6
Shale, black		..	7
Coal, very bony, *Bedford*		..	8
Clay, very siliceous		4	0

In this area the Upper Mercer limestone member lies close to 29 feet above the Lower Mercer limestone, 29 feet below the Putnam Hill limestone, and 90 feet below the Middle Kittanning coal. The formations extend with little change across western and central Pike Township. Usually the deposits contain both flint and limestone, the former either stratified or in nodules. The record given below was taken in the stream bed of Turkey Run, about one-half mile north of Bristol, in north central Section 19, Pike Township, Perry county:

		Ft.	*In.*
Sandstone, shaly		10	0
Shale, black, part covered		4	0
Coal, bony, 8 to 16 inches, *Tionesta*		..	6
Flint, black, irregular	*Upper Mercer*	1	0
Flint, irregular, dark		..	4
Limestone, blue, hard, fossiliferous		..	8
Covered.			

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[1] Geol. Survey Ohio, Fourth Series, Bull. 26, pp. 200-201.

In Clayton Township, the member locally is well developed and is made up of both gray and black flint, closely duplicating deposits near Warsaw in Holmes County. Evidence of quarrying by the aborigines is found at several places. Along the road that leads from the west branch of Butcherknife Creek to the ridge south in the east central part of Section 3, Clayton Township, Perry County, the following beds were exposed:

		Ft.	*In.*
Road forks on ridge, elevation 935 feet		..	..
Shale and covered		50	0
Flint, light gray, hard	*Upper Mercer*	3	4
Ore, siderite, local		..	4
Covered, probably shale		1	4
Flint, black, fossiliferous		3	0
Covered		1	0
Coal blossom, *Bedford*		1	0
Clay and shale		16	0
Limestone, blue, fossiliferous, *Lower Mercer*		1	0

To the north of this in Madison Township, Perry County, the Upper Mercer member is generally present, but is represented by limestone with flint nodules. The thickness of the deposits varies from a few inches to 3 feet or more. The member lies about 38 feet below the Putnam Hill limestone and 101 feet below the Middle Kittanning coal.

Muskingum County

In Muskingum County the Upper Mercer member is above drainage in Newton, Wayne, Springfield, Hopewell, Falls, Washington, Madison, Muskingum, Licking, Cass, Jefferson, Adams, and Jackson townships. In this county the most conspicuous feature by far is the frequency with which the member is represented by dark or even coal-black flint. In fact its representation by limestone is the exception to the rule. The coloration is due to carbon pigment augmented by iron compounds. The flint is very dense and solid except for small irregular cavities, often filled with small quartz crystals. The purer varieties are brittle, lustrous, and break with a deep conchoidal fracture. Such material was most certainly used by primitive man for much material was available along stream beds and on exposed knobs. Some of the main geological features will be brought out in the stratigraphic sections.

In a ravine east of Kent Run in the southeastern part of Section 1, west, the following rocks were exposed for measurement:

		Ft.	*In.*
Ore, concretionary, sideritic, *Upper Mercer*		..	6
Shale, dark, ferruginous	*Upper Mercer*	..	5
Flint, dark, irregular		1	5

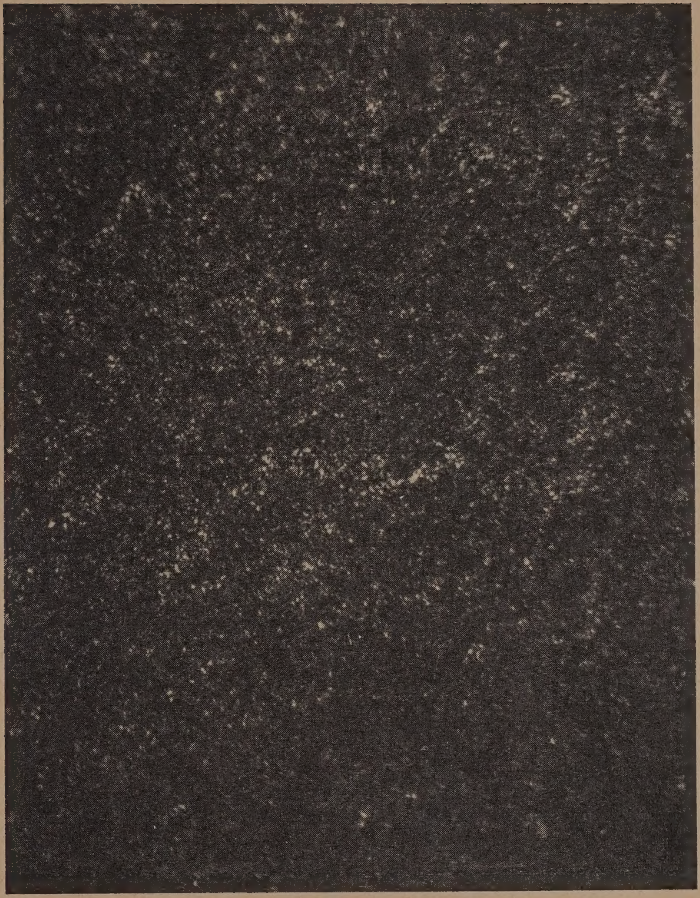

PLATE V

Photomicrograph of Upper Mercer Flint,
Lower Dark Phase

This flint has a fine grained structure with a larger proportion of isotropic matter than is usual in structurally sound flints. The isotropic matter in the photograph is dark and the anisotropic or crystallized matter is white or gray. Along cracks and in vugs the structure is coarser and more crystalline. There is some spicular matter but it is not pronounced. The material is largely silica with traces of pyrite but with no carbonate. Magnification 100 diameters Crossed nicols. N. E. ¼ of S.E. ¼ of Sec. 31 Clayton Twp., Perry County.

Shale, dark		..	5
Coal, cannel, bony, *Bedford*		..	3
Clay, siliceous		3	0
Shale and covered		20	0
Limestone, nodular, ferruginous, fossiliferous	*Lower Mercer*	1	0
Shale, dark, fossiliferous		1	5
Limestone, hard, gray, fossiliferous		1	6
Shale, carbonaceous		..	3
Coal, bony	*Middle Mercer*	..	1½
Coal, good		..	4
Clay, shale, and covered		21	0
Sandstone, massive, *Massillon*		47	0
Covered		5	0
Flood plain, elevation 780 feet		..	..

Locally in Springfield Township the Upper Mercer member is replaced by a massive sandstone and in the remainder of the area the bed is generally thin. Black flint is the common material or this overlain by iron ore. Much the same condition exists in southern Hopewell Township. In the northern part of this area the member has excellent continuity and commonly is represented by a medium to thick stratum of black flint.

The geology of the Upper Mercer member is well shown in the following record taken in the ravine north of the road at the Drumm Hill on the Harrison Drumm land in west central Section 14 and east central Section 15, Hopewell Township, Muskingum County:

		Ft.	*In.*
Flint, light, hard, massive	*Vanport*	2	0
Covered, probably shale		1	0
Limestone, siliceous, sparingly fossiliferous		..	10
Covered, probably shale		1	0
Limestone, thin-bedded, siliceous, fossiliferous		15	0
Covered		6	0
Shale, gray, siliceous		19	0
Limestone, bluish gray, fossiliferous, *Putnam Hill*		1	2
Shale, dark		..	2
Coal, impure, *Brookville*		..	1
Clay, light, siliceous		3	0
Sandstone, light, clay-bonded		5	0
Clay, dark, true flint	*Tionesta*	1	0
Clay, light, siliceous		2	0
Covered		5	0
Shale, gray, siliceous		2	0
Covered		4	0
Flint, black, irregular, *Upper Mercer*		1	0
Shale, dark		..	4
Coal, bony, cannel nature, *Bedford*		1	0
Clay, siliceous, light		1	8

Shale, siliceous	6	0
Sandstone, massive, with parts covered, replaces *Lower Mercer* limestone	33	0

At this place the Upper Mercer flint was sampled by R. A. Schoenlaub of the State Highway Testing Laboratory, in 1936, by taking a section through the bed. Analyst Downs Schaaf.

Silica, SiO_2	95.33
Alumina, Al_2O_3	0.29
Ferric oxide, Fe_2O_3	1.01
Ferrous oxide, FeO	1.14
Pyrite, FeS_2	0.05
Magnesium oxide, MgO	0.01
Calcium oxide, CaO	0.40
Sodium oxide, Na_2O	0.05
Potassium oxide, K_2O	0.09
Water, hydroscopic, H_2O-	0.27
Water, combined, H_2O+	0.44
Carbon dioxide, CO_2	0.74
Titanic oxide, TiO_2	0.02
Phosphorus pentoxide, P_2O_5	0.14
Sulphur trioxide, SO_3	<0.01
Manganous oxide, MnO	0.04
Zirconium oxide, ZrO_2	<0.01
Carbon, organic, C	0.22
Hydrogen, organic, H	0.03
Total	100.27

A photomicrograph of the flint from the Drumm Hill locality was made, 1936, by R. A. Schoenlaub of the State Highway Testing Laboratory. The plate follows:

In a ravine east of Bartlett Run, one and one-half miles north of Dillon Falls, on the J. Butler farm, in Falls Township, the geology of the Upper Mercer member for this area is well shown. The record secured follows:

		Ft.	*In.*
Limestone, gray, hard, *Putnam Hill,* elevation 863 feet		1	6
Covered		3	6
Sandstone, massive, *Homewood*		30	0
Shale, dark		13	0
Clay shale, light		1	0
Shale, gray		1	0
Ore, nodular, 3 to 6 inches, *Upper Mercer*		..	3
Shale, dark		..	3
Flint, black, irregular, *Upper Mercer*		1	1
Coal, bony, hard	*Bedford*	..	3
Shale, dark		..	2
Coal, bony, hard		..	6

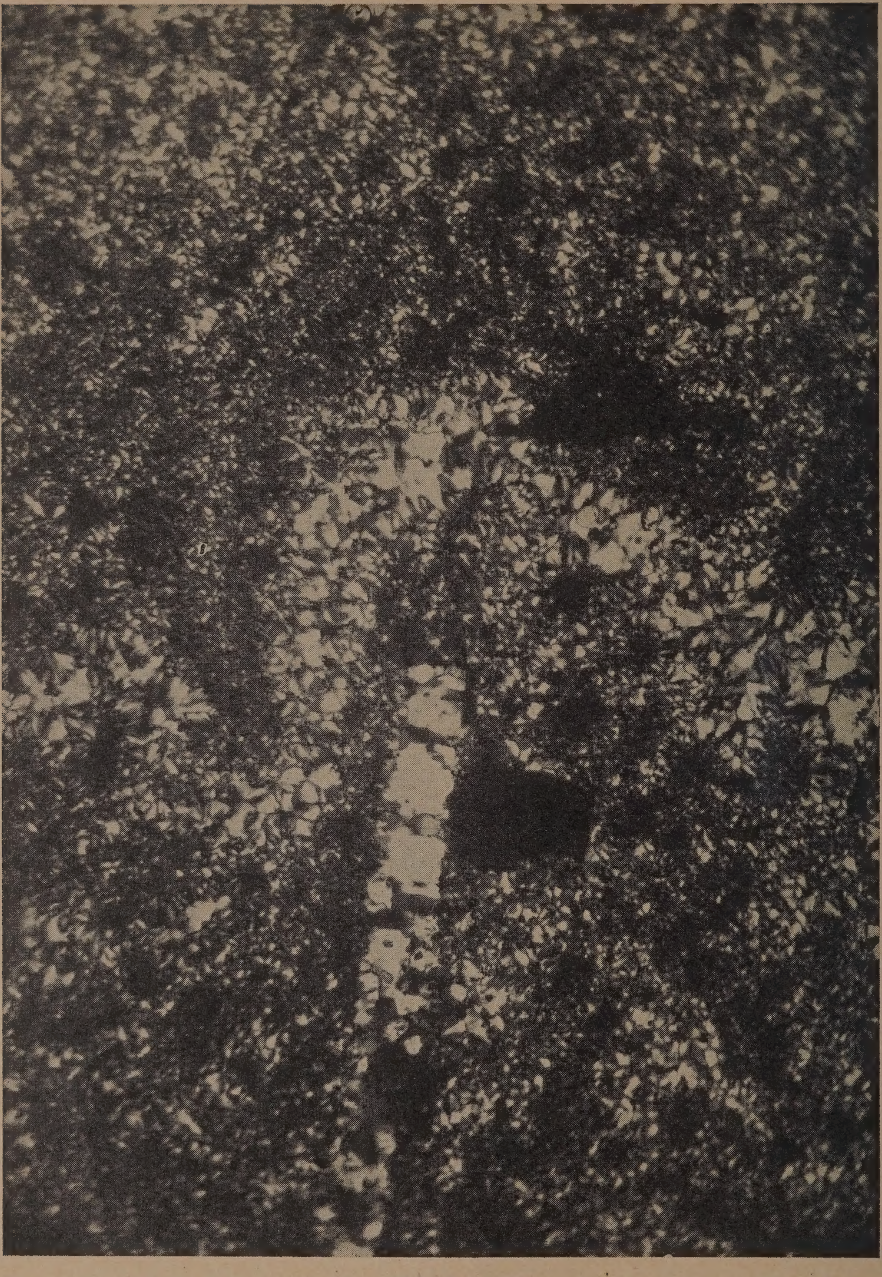

PLATE VI

Photomicrograph of Upper Mercer Flint

This photograph shows the texture of flint from Drumm Hill, Muskingum County. This flint is medium grained with a major proportion of the silica in the anisotropic or crystalline form. This flint is largely composed of fossil remains. There is some ankerite and some limonite stain. Magnification 100 diameters. Crossed nicols. N-90.

Clay, light		2	6
Coal, bony		..	6
Clay, light		1	0
Sandstone, shaly		2	6
Shale, siliceous		3	6
Coal, bony, cannel nature, *Upper Mercer*		1	0
Clay, light, plastic		2	6
Shale and shaly sandstone		6	0
Shale, calcareous, fossiliferous	*Lower Mercer*	1	6
Limestone, hard, fossiliferous		..	4
Shale, calcareous, fossiliferous		..	2
Limestone, hard, fossiliferous		1	4
Shale, dark, carbonaceous		..	4
Coal, bony, *Middle Mercer*		..	10
Clay, dark, carbonaceous		1	0
Clay, siliceous, light		6	0
Clay, plastic, light		1	6
Sandstone, shaly		2	0
Shales, gray, siliceous		5	0
Clay, light, siliceous		4	0
Shale, siliceous		2	0
Sandstone, shaly		1	0
Shales, siliceous		3	0
Clay shale, light, iron mottled		3	0
Shale, blue		5	0
Flint, light, ferruginous, irregular	*Boggs*	1	0
Sandstone, flinty, ferruginous		..	6
Shales, dark, siliceous		1	6
Sandstone, massive, *Massillon*		33	0

In Licking Township the Upper Mercer member is confined to the knobs and ridges in the eastern part of the area. Usually it is represented by black flint from 6 inches to 1 foot 6 inches in thickness. The best developed deposits are in the northeastern part, west of Shannon.

Throughout Muskingum Township, Muskingum County, the Upper Mercer horizon is well marked by deposits of black flint, of hard blue limestone, or of some combination of these. The deposits outcrop along the stream courses in many places, thus providing good quarry sites. The stratigraphy of the member is well shown in the record given below and taken along Blunt Run in northeastern Section 20, Muskingum Township:

		Ft.	*In.*
Shale and covered		20	0
Coal, good	*Middle Kittanning*	1	11
Shale, impure		..	1
Coal, good		1	0
Clay and covered		8	0
Sandstone and covered		4	0
Sandstone, massive		22	0

Shales, parts siliceous, parts covered		38	0
Limestone, gray, hard, *Putnam Hill*		4	2
Covered		6	0
Shale, gray		3	0
Clay and covered		6	6
Coal blossom, *Tionesta*		..	6
Clay, siliceous, light		2	0
Sandstone, shaly		10	0
Shales, dark		8	0
Covered		10	6
Flint, black, hard, *Upper Mercer*		1	6
Coal, not well exposed, *Bedford*		2	0
Sandstone, highly cross-bedded		9	0
Shale, gray		4	5
Limestone, hard, fossiliferous	*Lower Mercer*	..	7
Limestone, shaly, very fossiliferous		1	3
Limestone, hard, dark, fossiliferous		..	6
Limestone, shaly, fossiliferous		..	3
Limestone, hard, fossiliferous		1	9
Coal, bony	*Middle Mercer*	..	2
Shale, dark, carbonaceous		..	4
Coal, bony		..	3
Sandstone very irregular, plant marked		2	0
Clay, light		3	0
Shales, gray		9	11
Ore, kidney	*Boggs*	..	2
Shale, dark, calcareous, fossiliferous		4	0
Limestone, dark, gray, fossiliferous		1	3

In Washington Township the deposits of flint or limestone are confined to the bluffs along the Muskingum River and to the lower courses of the small streams flowing into the river. The flint is variable in thickness but usually it is not over 1 foot. Otherwise the geological features are about normal.

Locally in Madison Township the deposits show considerable expansion especially along the Muskingum River front near Rock Cut and along Symmes Creek near its mouth. The record given below was taken near the mouth of the first eastern tributary of North Branch, one-fourth mile northeast of the cross roads on Symmes Creek:

		Ft.	*In.*
Sandstone, massive, *Clarion*		30	0
Shale and covered		10	0
Limestone, blue, fossiliferous	*Putnam Hill*	1	1
Shale, fossiliferous, with iron nodules		4	0
Limestone, gray, fossiliferous		3	10
Shale, dark		..	2
Coal, good	*Brookville*	1	0
Shale, carbonaceous		..	0½
Coal, good		..	10

Clay, plastic		2	0
Covered		13	0
Sandstone, shaly		18	0
Shale and covered		3	0
Flint, black, irregular	*Upper Mercer*	3	0
		2	3
Limestone, flinty, very fossiliferous		2	3
Shale, dark		..	1
Coal, bony	*Bedford*	..	5
Shale, carbonaceous		..	2
Coal, bony		1	2
Clay, siliceous		3	0
Covered		1	11
Sandstone, shaly		7	0
Shales, siliceous		5	0
Limestone, shaly, fossiliferous	*Lower Mercer*	1	6
Limestone, hard, dark, fossiliferous		..	9
Limestone, part shaly, fossiliferous		..	5
Limestone, hard, dark, fossiliferous		1	11
Shale, dark		..	4
Coal, bony, *Middle Mercer*		..	8
Clay, siliceous, light		1	8
Sandstone, shaly		3	0
Shale, gray, siliceous		5	4
Limestone, very ferruginous, fossiliferous	*Boggs*	..	4
Limestone, dark, hard, fossiliferous		..	4

The area of outcrop of the Upper Mercer limestone member is small in Adams Township, being confined to the bluff south of Wills Creek near its mouth. The deposits here are flinty limestone approximating 1 foot 8 inches in thickness. Its position is about 21 feet above the top of the Lower Mercer limestone and 42 feet below the base of the Putnam Hill limestone.

The continuity of the Upper Mercer member is excellent in Cass Township but the thickness of the deposits, in general, ranges between 8 inches and 1 foot 10 inches. Black flint is the most common representative. The geological features are well exhibited in the record given below and taken along the road that leads from the stream to the ridge west about one mile southwest of the north end of Dresden in east central Cass Township:

	Ft.	*In.*
Sandstone, part covered	20	0
Coal, reported thickness, *Middle Kittanning*	3	0
Clay and covered, with nodular limestone	23	0
Clay, flint and plastic, *Lower Kittanning*	9	0
Covered	21	0
Shales, siliceous	37	0
Limestone, gray, dense, *Putnam Hill*	2	0

Clay and covered		7	0
Sandstone, shaly		11	0
Shale, gray, siliceous		4	2
Flint, black, irregular	*Upper Mercer*	..	8
Limestone, with black flint nodules		1	2
Shale, dark		..	4
Coal, fair	*Bedford*	..	4
Clay, light, siliceous		4	4
Sandstone, shaly		5	0
Coal, good		1	6
Clay, light, siliceous		3	6
Sandstone, shaly		9	0
Shale, black, bony, with coal bands, *Upper Mercer*		1	0
Clay, light, siliceous		1	0
Sandstone, shaly		9	0
Shales, blue, calcareous		2	0
Limestone, shaly, very fossiliferous	*Lower Mercer*	2	0
Limestone, hard, dark, fossiliferous		1	3
Limestone, hard, dark, fossiliferous		1	6
Limestone, hard, dark, fossiliferous		..	10
Limestone, hard, dark, fossiliferous		1	0
Coal, bony, *Middle Mercer*		..	6
Clay, light, siliceous		2	0
Sandstone, argillaceous		5	6
Shale, black, hard, fissile, *Flint Ridge* coal horizon		..	6
Sandstone, light, argillaceous		5	2
Ore, blocky, *Boggs*		..	4
Coal, impure, *Lower Mercer*		..	1
Clay, light, siliceous, lower part shaly		8	0

In Jackson Township, Muskingum County, the Upper Mercer limestone member is due only along the main ridges and on the high knobs in the eastern part of the area. However, it is replaced by a massive sandstone in much of this field. In the few deposits observed the flint is from 8 inches to 1 foot 4 inches in thickness. The stratigraphic geology presents no new features.

Coshocton County

The Upper Mercer member crosses Coshocton County from south to north in a rather wide area of outcrop. It is present in large areas in Washington, Virginia, Bedford, Jackson, Jefferson, Bethlehem, Monroe, and Clark townships. It appears also along ridges and knobs in Pike and Perry townships and not far above drainage in Franklin, Tuscarawas, Keene, and Mill Creek townships. Locally the member is replaced by sandstone. Where present deposits vary from thick to thin and from flint to limestone. The flint deposits of most prominence are in Jefferson Township where they were worked rather extensively by primitive man.

Here both hard black flint and dense gray flint are present. Some of the most prominent deposits will be described.

In Pike and Washington townships the member is only locally represented as it is frequently replaced by sandstone. Where present the deposits are generally thin but flint in character. Some of the stratigraphic features are shown in the record given below and taken along the road that leads from the small valley west of Moscow Brook to the ridge west in northwest Section 15, Virginia Township, Coshocton County:

		Ft.	*In.*
Shales and covered		15	0
Limestone, nodular, *Hamden*		1	0
Clay and covered		26	0
Limestone, upper part flinty, *Vanport*		5	0
Covered		16	0
Limestone, gray, fossiliferous, *Putnam Hill*		4	0
Shales and covered		57	0
Flint, black, dense, *Upper Mercer*		2	2
Shale and covered		15	0
Limestone, dark, hard, fossiliferous	*Lower Mercer*	1	6
Limestone, dark, hard, fossiliferous		1	0
Limestone, dark, hard, fossiliferous		1	8

The member shows good continuity in Bedford Township but in general the deposits are not outstanding as to thickness. The flint is underlain by cannel coal varying from 3 to 6 feet in thickness. For Ohio the deposits reach their maximum thickness in that part of Jefferson Township west of Warsaw and south of the Walhonding River. This is shown in the section taken by T. R. Meyers[1] at the head of Flint Run, along the road to Mohawk Village, Jefferson Township, and given below:

		Ft.	*In.*
"Limestone, *Putnam Hill*		6	6
Covered interval		17	11
Flint, buff-colored	*Upper Mercer*	2	1
Flint, hard, black, fossiliferous		11	8
Limestone, dark blue, with irregular masses of flint		5	6
Clay shale		..	8
Coal, weathered	*Bedford*	..	4
Clay shale, light-colored		..	1
Coal, cannel, shaly		..	11
Clay, light-colored, plastic		2	6"

In the ravine north of the road that leads to Mohawk Village, at the head of Flint Run, on the J. P. Wheeler farm, Jefferson Township, the strata given below were sectioned:

---

[1] Meyers, Theodore Ralph, thesis, 1929, Ohio State University, The Geology of Jefferson and Bedford Townships, Coshocton County, pp. 51–52.

		Ft.	*In.*
Limestone, shaly, poorly exposed, *Vanport*		5	0
Coal blossom, *Clarion*		1	0
Clay and covered		4	0
Shale and covered		32	0
Limestone, gray, *Putnam Hill*		3	0
Shales and covered		27	6
Flint, gray, with shaly limestone lenses	*Upper Mercer*	5	0
Flint, black, with gray limestone nodules		2	6
Shale, dark		1	5
Coal, weathered	*Bedford*	..	3
Shale, dark		..	4
Coal, cannel		2	1
Clay, light, siliceous		5	0
Shale and covered		8	0
Limestone, hard, gray	*Lower Mercer*	1	2
Limestone, hard, gray		2	9

The chief quarries worked by the adorigines were north and northwest of Flint Run and along the ridges east of Mohawk Village.

On the Lee Moore farm about one mile east of the village the beds recorded below were exposed for measurement:

		Ft.	*In.*
Limestone, hard, *Putnam Hill*		5	0
Covered		41	9
Flint, gray, calcareous	*Upper Mercer*	1	3
Shale, gray, calcareous		..	2
Limestone, gray, shaly, very fossiliferous		2	2
Shale, gray, calcareous		2	8
Flint, black, with gray limestone		1	9
Coal, bituminous, with bone partings	*Bedford*	2	2
Coal, cannel, good		5	6

North of the Walhonding River in Coshocton County the deposits of the Upper Mercer member again become normal and consist of either flint or limestone or both, seldom more than 2 feet in thickness. In the eastern townships along the Muskingum and Tuscarawas rivers and along Killbuck, Mill, and White Eyes creeks, limestone instead of flint is the usual representative.

Holmes County

The Upper Mercer member undergoes considerable change in Holmes County. In large areas, especially in Killbuck, Mechanic, Hardy, Berlin, Salt Creek, and Paint townships, it is either represented by shale or replaced by sandstone. The deposits are conspicuous in Prairie, Walnut

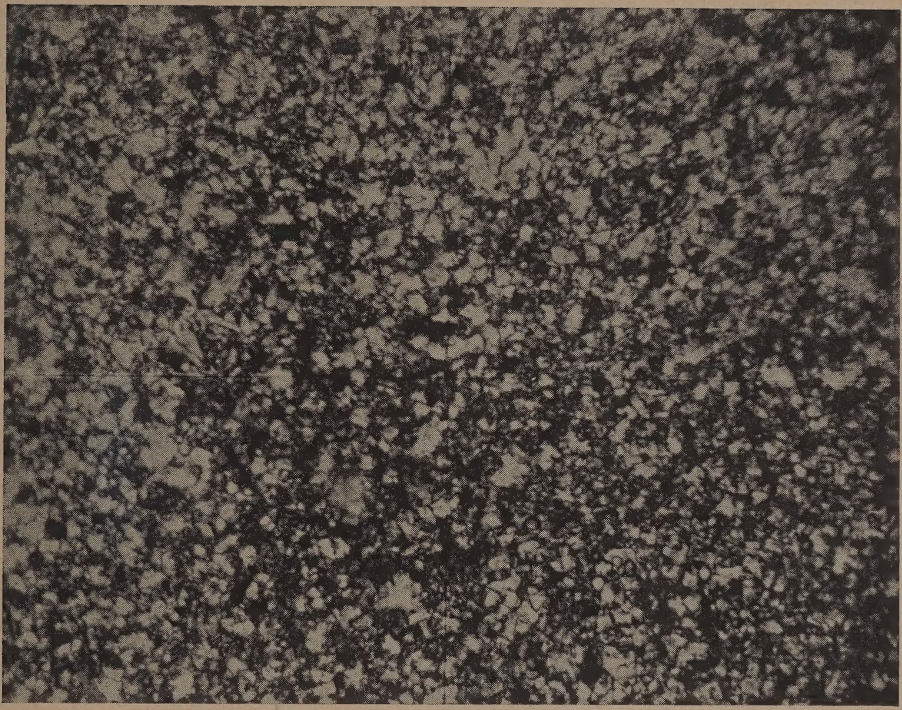

PLATE VII

Photomicrograph of Gray Flint from
Upper Phase of Upper Mercer

This flint has a coarse grained structure which is quite uniform and predominately anisotropic or crystalline matter. There are some irregular grains of carbonate which do not show a recognizable crystal face and there is some pyrite. There are no recognizable fossil remains. Three miles west of Warsaw. 1684:11, Frederick Farm, Jefferson Twp., Coshocton Co.

Creek, and Clark (formerly German) townships but are limestone or flint limestone and not flint. A few sections will suffice to show the general geology of the formation.

Throughout Holmes County the Upper Mercer limestone is a persistent and prominent member and has an average thickness close to 2 feet. “The Upper Mercer limestone is dark, blue-gray in color, and is usually quite fine in texture. The flint associated with the limestone is always a blue-black, dense flint, with some mottling exhibited but not arranged in layers. The flint is almost vitreous in lustre, very brittle, and has a conchoidal fracture.”[1] A few sections from the same source follow:

“In the northwestern corner of Clark Township the Upper Mercer limestone outcrops near the stream in the vicinity of Charm about 1,060 feet above tide. The member under discussion has the following structure where seen along the road in the southeastern corner of Section 5, Clark Township:

		Ft.	*In.*
Limestone, hard, dark blue, fossiliferous	*Upper Mercer*	..	5
Flint, black		..	11
Limestone, dark, flinty		..	3
Coal, somewhat shaly, *Bedford*		2	0
Clay, siliceous		3	0
Shale and covered		20	6
Limestone, blue, fossiliferous, *Lower Mercer*		1	6[2]

“In general in Walnut Creek Township, Holmes County, the bed is found in the central, northwestern, and southern parts and is absent from the northern and northeastern parts. In the northwestern part of the township the marine member under discussion overlies the Bedford coal at an altitude of approximately 1,085 feet. Just north of the road forks in the valley of Indian Trail Creek two miles west of Trail the following section was obtained up the road from Indian Trail Creek:

	Ft.	*In.*
“Shale, sandy	15	0
Limestone, hard, dark, blue, fossiliferous, with much flint, *Upper Mercer*	2	2
Coal and covered	2	0
Clay, clay shale, and covered	5	10
Shale, hard, black, carbonaceous, *Upper Mercer* coal	3	2
Clay and covered	5	0”

“In Prairie Township the Upper Mercer limestone is present in the northeastern and southeastern corners of the area. The structure and character of the Upper Mercer limestone and flint are shown by the following section measured at the mouth of an old mine in the northeastern corner of Section 1:

---

[1] Unpublished report by George W. White on the geology of Holmes County.
[2] Idem.

		Ft.	In.
"Soil, sand derived		3	0
Flint, very fossiliferous, dark to tan, weathered	*Upper Mercer*	..	10
Limestone, weathered to clay		1	1
Flint, black, fossiliferous		3	3
Coal, weathered, *Bedford*		3	4
Clay shale, dark, soft			"

Wayne County

Regarding Wayne County Conrey states:[1] "The Upper Mercer limestone outcrops where due at comparatively few places in the county, although it has been recognized in four different townships. It is usually known as the blue limestone because of its dark color. In addition to its color the hard flinty nature of much of the member is especially noticeable. Attempts have been made to burn the stone for agricultural lime, but as it was largely flint the results were unsuccessful. The position of this bed is about 20 to 25 feet above the Lower Mercer limestone and 45 to 50 feet below the Putnam Hill. Its thickness varies from 1 to 3 feet, with an average of a little less than 2 feet."

The following record was taken near the center of Section 24, Paint Township. The member was exposed along the highway; and on the hillside a short distance to the east the Putnam Hill has been quarried:[2]

	Ft.	In.
"Limestone, gray, *Putnam Hill*	4	0
Interval	45	0
Limestone, dark blue, flinty, *Upper Mercer*	2	6
Coal blossom, *Bedford*	1	0
Clay and covered	5	0
Sandstone	20	0"

The other deposits show limestone or this with black flint nodules.

Tuscarawas, Stark, Summit and Portage Counties

The strata of the Upper Mercer formation appear along the streams in the northwestern part of Tuscarawas County in several townships and along the valley of the Tuscarawas River from Bolivar to Zoar Station. The usual representative is limestone or limestone with flint nodules, from 1 to 3 feet in thickness. The conditions are much the same throughout Stark, southeastern Summit, and southern Portage counties. Locally a thin layer of flint appears. The general geology is well represented by the following section taken at the brick plant at Bolivar, Tuscarawas County:

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[1] Geol. Survey Ohio, Fourth Series, Bull. 24, p. 107.
[2] Idem. p. 107.

	Ft.	In.
Limestone, shaly, fossiliferous, lower phase of *Vanport*	3	0
Clay shale	1	0
Shale, gray, siliceous	14	0
Shale, ferruginous with boulders of very fossiliferous limestone, upper *Putnam Hill*	..	8
Shales, fossiliferous	13	6
Limestone, hard, gray, *Putnam Hill*	1	9
Limestone, shaly, dark	..	3
Shale, bony	..	4
Coal, reported, *Brookville*	2	4
Clay, shale, sandstone, and covered	33	6
Flint, black, irregular, *Upper Mercer*	..	6
Coal blossom, shaly, *Bedford*	1	0
Clay, siliceous	2	0
Shale and shaly sandstone	25	0
Limestone, hard, gray, *Lower Mercer*	2	6

Mahoning and Trumbull Counties

In Mahoning and southern Trumbull counties limestone occurs with some regularity on the Upper Mercer horizon. Where present the deposits have good thickness, from 1 to 3 feet, but they contain little or no flint.

Thus when traced across the State from south to north the Upper Mercer member appears first in Lawrence, Scioto, Jackson, and Vinton counties as an iron ore, then as black flint through Hocking, Perry, Muskingum, and Coshocton counties, then as a mixture of flint and limestone through Holmes and Wayne counties, and as limestone with little or no flint in Tuscarawas, Stark, Summit, Portage, Mahoning, and Trumbull counties. The flint deposits with most massive development are in Perry, Muskingum, and Coshocton counties. Throughout this area primitive man thus gathered much material for fashioning into useful implements and for ornaments. In importance for flint supply the Upper Mercer should rank next to the Vanport but not far above the Zaleski.

PUTNAM HILL MEMBER

In Ohio the Putnam Hill member is characteristically developed and very steady in a large interior field including parts of Stark, Summit, Wayne, Tuscarawas, Holmes, Coshocton, Muskingum, Licking, and Perry counties. South of this in Hocking and in northern Vinton counties, the bed is wanting or very feebly developed. It appears again, however, in southern Vinton and in Jackson counties in a modified form, that is, as deposits of calcareous shale and shaly limestone, both very fossiliferous

PLATE VIII

Photomicrograph of Unknown Flint

The flint has a texture very similar to that shown in Plate VII, except it is somewhat finer grained and contains a larger proportion of isotropic matter. It contains carbonate and pyrite in shapes suggestive of organic origin. Sample 3, 1649:13Plum Run Quarry, Mahoning County, South Twp., S.W. ¼ of Sec. 31, Alliance. Magnification 100 diameters, crossed nicols.

and unlike the type material, chemically, physically, and faunally. Throughout Ohio the member is never represented by flint and only locally even contains flint or chert nodules. It furnished no material for primitive man.

ZALESKI MEMBER

The most characteristic material on the Zaleski horizon is a black or brownish black flint, hard and lustrous. This material breaks in any direction with a deep conchoidal fracture and with sharp edges. The coloring pigment appears to be most largely disseminated carbon. Like most dense strata in the coal formations, it is regularly divided by joint planes into rectangular blocks. Aside from the true flint, the horizon also yields calcareous flint, siliceous limestone, calcareous shale, and iron ore. In the limy varieties the color varies from light gray to grayish brown, the shale decreasing as the lime increases. The calcareous flint and siliceous limestone are exceedingly fossiliferous whereas the hard flint is sparingly so.

In Ohio the Zaleski member with its associated Ogan and Winters coals has as yet been recognized only in southern Vinton and northern Jackson counties. The basin thus appears to be small, as now outlined, covering an area of not more than 130 square miles. The deposits are best developed near McArthur, Zaleski, and Hamden. The stratigraphic position of the Zaleski member is, on the average, about midway between the Brookville coal and the Clarion coal, or 26 feet above the Brookville coal and 27 feet below the Clarion. These intervals, however, vary much and erratically from place to place. The flint usually forms the roof of the Ogan coal and the floor for the clay of the Winters coal. The mean thickness of the Zaleski member from more than thirty measurements is 1 foot 2 inches but the variation is from a few inches to about 5 feet.

In Jackson County the flint is confined to local areas in Coal, Washington, and Milton townships. In Coal Township the area is small. In the central part of Section 3, Coal Township, loose pieces of black flint were observed on the summit of the high ridge, but the bed was not exposed for measurement.

A few deposits are quite conspicuous in Washington Township of Jackson County. Near the Town House, in Section 21, the black flint is exposed and measures at least 1 foot in thickness. Its position is 22 feet above the Brookville coal, 82 feet above the Upper Mercer coal, and 273 feet above the Sharon coal. It is also exposed north of the Town House and on the knob near the forks of the road in Section 22 and appears in small areas in Sections 15 and 9.

The Zaleski black flint with the associated coals is found in a few places in northern Milton Township, Jackson County. The section obtained in the mines of the Minglewood Coal Company, in Section 34, Milton Township, shows the stratigraphic relations found here.

	Ft.	*In.*
Coal blossom, *Clarion*	3	6
Clay and covered	9	0
Coal blossom, *Winters*	2	0
Clay and covered	1	0
Flint, black, fossiliferous, *Zaleski*	1	0
Shale and covered	18	6
Coal blossom, *Brookville*	1	0

The Zaleski member reaches its maximum development in southern and central Vinton County. Here also its true relations to the overlying Winters coal and to the underlying Ogan coal are clearly revealed. Throughout this area primitive man most certainly gathered much flint for implements as chipping grounds are evident in many places and as quarries were opened in several localities. Further, much good solid flint was available along stream beds. From the evidences these deposits ranked about third in the State, Vanport flint first, Upper Mercer second, and Zaleski third. Many flint implements, most certainly Zaleski flint, are found along the Scioto Valley, especially from Chillicothe to the Ohio River. The better deposits will be described.

The Zaleski flint is patchily developed in eastern Richland Township where it is due along the main ridges and on the high knobs. Further, the bed is variable in thickness and in quality. The deposits are most prominent in sections 32, 13, 11, 2, and 1, north.

Along the ridges and high knobs in northeastern and central Section 32, Richland Township, much flint is scattered on the surface. Near the section line in the east central part of the area the following record was secured:

	Ft.	*In.*
Top of high knob, 1,045 feet elevation	..	..
Shale and covered	25	0
Coal blossom, *Winters*	1	6
Clay, part covered	1	6
Flint, black, hard, good, *Zaleski*	1	0
Covered	3	0
Sandstone, shaly	6	0
Shale and covered	10	0
Coal blossom, *Brookville*	2	0

Some evidences of quarries are apparent in this area. The flint is of good quality for chipping and was readily available to primitive man. The next deposit of any prominence observed north of this in Richland Township is in southwestern and central Section 13. Along the road east of the cross-roads in south central Section 13 the Zaleski flint is prominent. The section obtained is given below:

		Ft.	In.
Clay, plastic, *Clarion*		5	0
Shale, argillaceous, gray		4	6
Coal and coaly shale		1	2
Clay, light, plastic		4	0
Sandstone, light, clay-bonded		10	0
Covered		6	0
Flint, dark to gray	*Zaleski*, elevation 970 feet	..	10
Shale, impure		..	2
Flint, gray, siliceous		..	4
Shale, siliceous		..	7
Coal, smut, *Ogan*		..	7
Clay, plastic, siliceous		1	0

The Zaleski flint is present at an elevation of about 1,000 feet on the knobs and ridges in the central part of Section 11, Richland Township. Old quarries are evident in a few places, the most prominent ones on the knobs north of the road in the western part of the area. In general the flint is from 6 inches to 1 foot in thickness, black in color, hard and lustrous in character. Some of the geological features are given in the following record:

		Ft.	In.
Flint, black, *Zaleski*, elevation 1,000 feet		..	10
Covered		31	6
Coal blossom, *Brookville* or *Newland*		..	8
Clay, impure		1	0
Sandstone, shaly, dark		4	8
Shale, gray		1	10
Shale, black, carbonaceous		..	4
Coal, weathered, prospect opening, *Tionesta*		1	11
Covered		58	0
Limestone, hard, blue, fossiliferous, *Lower Mercer*		..	7
Clay and covered		12	0
Coal, smut, *Lower Mercer*		..	1
Clay, siliceous		2	0
Sandstone, shaly	*Massillon*	12	0
Sandstone, soft, massive		37	0

Flint quarries of a rather extensive nature are found at the Frank E. Farnsworth farm, along the ridge in the southeastern part of Section 2, Richland Township. The flint is from 8 inches to 1 foot in thickness and lies at an elevation of 990 feet. Here its position is 40 feet above the Brookville or Newland coal.

The Zaleski member shows similar development along the high ridge west of the Pawpaw School in west central Section 1, north, Richland

Township. The following record was secured along the road south of the school:

		Ft.	In.
Limestone and flint, *Vanport*		2	0
Covered		6	0
Road forks, elevation 975 feet		..	..
Covered		7	0
Shale, dark, *Winters* coal horizon		1	0
Clay, not well exposed		4	6
Flint, black, good, *Zaleski*		..	10
Covered		4	2
Coal blossom, *Ogan*		1	0
Clay and covered		10	0
Covered		17	0
Coal, *Brookville*		1	0
Clay and covered		4	0
Shale, siliceous		6	4
Ore, blocky, *Upper Mercer*		..	4
Flint, dark gray, fossiliferous, *Upper Mercer*		..	4
Shale, very siliceous		15	0
Covered		26	0
Limestone, shaly, fossiliferous	*Lower Mercer*	5	0
Limestone, hard, fossiliferous		1	1

The Zaleski flint member lacks continuity in Clinton Township. Where present the deposits are generally thin and the flint of the gray, impure variety. However, in one locality it shows good development and high quality. On the Tarr farm, south of the road and just north of the center of Section 23, Clinton Township, the following measurements were made:

		Ft.	In.
Limestone, weathered, poorly exposed, *Vanport*		..	..
Coal blossom, *Clarion*		2	0
Covered		11	0
Sandstone, soft, light		10	0
Clay shale, light		..	5
Coal, good	*Winters*	1	6
Clay, impure		0	3
Coal, somewhat bony		1	1
Coal, bony, and shale		..	7
Clay, part covered		1	6
Flint, black, hard, *Zaleski*		1	10

In Elk Township the deposits of Zaleski flint are confined most largely to the eastern part of the area and show much variation in both thickness and quality. Further, the associated coals reach high development. Much flint was gathered from this field by primitive man.

On the William Elliott property in the east central part of Section 26, Elk Township, the following beds were exposed for measurement:

	Ft.	In.
Shale, dark, carbonaceous	6	0
Coal, good	1	2
Shale, impure *Winters*	..	1
Coal, good	..	6
Shale, impure	..	2
Coal, good	2	0
Clay, very siliceous	1	1
Flint, black, solid, blocky, *Zaleski*	1	1
Shale, black	..	5
Coal, good, *Ogan*	..	9
Clay, plastic	2	0
Covered	28	0
Coal blossom, *Brookville*	2	6

In Spook Hollow in the southwestern part of Section 23, Elk Township, the flint is present in massive development. The strata measured are given below:

	Ft.	In.
Coal, formerly mined, not well exposed, *Winters*	..	..
Flint, gray to black, massive, *Zaleski*	1	8
Shale and covered	41	0

Where observed in Section 22, Elk Township, the flint deposits vary from 6 to 12 inches in thickness and from pure to calcareous in quality. Its position is about 30 feet above the Brookville coal. The most massive deposit of the solid black flint found in the entire area is on the property of the Ogan heirs, along the abandoned road in the south central part of Section 14, Elk Township. The section follows:

	Ft.	In.
Coal blossom, *Winters*	2	0
Clay and covered	3	0
Flint, black, vitreous, *Zaleski*, elevation 800 feet	3	2
Coal, good	..	8
Shale, dark *Ogan*	..	5
Coal, good	1	7
Shale and covered	19	0
Coal blossom, *Brookville* or *Newland*	2	0
Clay and covered	5	0

At this place on the Ogan property the Zaleski flint was sampled, in 1936, by R. A. Schoenlaub of the State Highway Testing Laboratory. Analyst, Downs Schaaf.

Silica, SiO_2	94.72
Alumina, Al_2O_3	0.59

Ferric oxide, Fe_2O_3	0.10
Ferrous oxide, FeO	0.55
Pyrite, FeS_2	0.14
Magnesium oxide, MgO	0.02
Calcium oxide, CaO	1.29
Sodium oxide, Na_2O	0.06
Potassium oxide, K_2O	0.09
Water, hydroscopic, H_2O-	0.50
Water, combined, H_2O+	0.65
Carbon dioxide, CO_2	1.07
Titanic oxide, TiO_2	0.09
Phosphorus pentoxide, P_2O_5	0.14
Sulphur trioxide, SO_3	<0.01
Manganous oxide, MnO	<0.01
Zirconium oxide, ZrO_2	<0.01
Carbon, organic, C	0.24
Hydrogen, organic, H	0.03
Total	100.28

Some of the local variations in the character of the flint are shown in the record given below and taken along the road in the northeastern part of Section 15 and the northwestern part of Section 14, Elk Township.

		Ft.	*In.*
Top of ridge, elevation 965 feet		..	..
Covered		11	0
Sandstone, massive		20	0
Coal blossom, *Lower Kittanning*		3	0
Shales and covered		60	0
Coal, old mine, *Clarion*		3	0
Covered		4	0
Sandstone		4	0
Covered		10	0
Flint, shaly, dark gray	*Zaleski*	..	8
Flint, gray		..	5
Flint, shaly		..	2
Flint, dark gray		..	4
Flint, shaly,		..	0½
Flint, gray to dark		..	8

The deposits of Zaleski flint observed in the southern part of Section 11 are also of good thickness and quality. The geology of the member is well shown in the record given below and measured along the road in the southeastern corner of Section 11, Elk Township:

	Ft.	*In.*
Road forks, elevation, 891 feet	..	..
Sandstone, soft, massive	29	0
Coal blossom, *Clarion*	2	0
Clay and covered	6	0

Shale, gray		24	0
Coal, bony	*Winters*	..	7
Shale, black		..	7
Coal, good		..	2
Clay, impure		..	3
Shale, black		..	5
Coal, good		..	7
Clay shale		2	4
Coal, shaly		..	1
Clay, plastic		..	7
Flint, black to gray, hard, *Zaleski*		2	11
Coal, bony	*Ogan*	1	1
Shale, black		..	7
Clay, light, plastic		1	0
Coal, good		..	7
Clay, light, plastic		5	0
Ore, kidney		..	2
Shale, gray		10	10
Shale, calcareous, fossiliferous, *Putnam Hill*		3	0
Coal, bony	*Brookville*	1	8
Clay, dark		..	11
Coal, bony		..	7
Clay, plastic, good		4	0

From old chipping grounds the material in this general area was used to some extent for the manufacture of implements. The dark flint is of much better quality than the gray variety. The continuity of the member is good in the area east of Raccoon Creek in Elk Township. The following record was secured on the property of Mrs. H. J. Malone in the north central part of Section 1.

		Ft.	*In.*
Coal blossom, *Lower Kittanning*, elevation 930 feet		1	0
Clay and covered		5	0
Covered		17	0
Limestone, gray, *Vanport*		..	10
Shale and covered		30	0
Old mine, *Clarion* coal		2	0
Covered		40	0
Flint, gray, shaly	*Zaleski*	1	1
Flint, gray, 10 to 14 inches		1	0
Coal, shaly	*Ogan*	..	5
Shale, coaly		..	3
Coal, good		..	6
Coal, bony, cannel nature		..	4
Shale, coaly		..	0½
Coal, bony, cannel nature		..	1
Coal, good		..	9

In Madison Township the Zaleski flint appears only in the west central part of the area, west of Prattsville. Here locally the member has good

PLATE IX

Photomicrograph of Zaleski Flint

This photograph shows the texture of Zaleski flint from the Ogan Farm near Zaleski. This flint has an exceedingly characteristic texture, its distinguishing feature is the numerous spicular anisotropic particles of heterogeneous orientation. This flint is of medium grained structure, and moderately uniform. Magnification 100 diameters. Crossed nicols.

thickness and fair quality. Near stream level in the west central part of Section 33, Madison Township, the following beds were exposed for measurement:

		Ft.	In.
Flint, dark brown to black	*Zaleski*	1	0
Flint, dark gray		..	6
Flint, dark, shaly		..	7
Coal, good, *Ogan*		..	8
Clay, siliceous		1	0

The area of Zaleski flint in Brown Township is small as the deposits are confined to a few sections in the southwestern part. In general the deposits are thin and the flint of only fair quality. The geological features are well shown in the record given below and taken along the road that leads from Raccoon Creek to the ridge south in the southwestern corner of Section 32 and the northwestern corner of Section 31, Brown Township:

		Ft.	In.
Road divide, elevation 962 feet		..	..
Sandstone, massive, soft, *Lower Freeport*		56	0
Coal blossom, *Lower Kittanning*		1	0
Clay, siliceous		2	0
Shale and covered		19	0
Coal blossom, *Lower Kittanning*		1	0
Clay, light, plastic		16	0
Sandstone, light, soft		16	0
Shale, gray, siliceous		15	0
Covered		2	10
Coal blossom, *Clarion*		1	6
Clay, light, plastic		7	8
Shale, siliceous, light gray		10	0
Clay, light, plastic		1	6
Shale, siliceous, light		2	6
Sandstone, shaly, light gray		4	0
Shale, gray, siliceous		10	0
Coal smut, *Winters*		..	1
Clay, light, shaly		1	4
Flint, gray, 4 to 8 inches, *Zaleski*		..	6
Shale, dark		..	6
Coal, weathered, *Ogan*		2	8
Shale, dark		1	0
Clay shale and shale		8	0
Shale, very fossiliferous	*Putnam Hill*	1	0
Limestone, blocky, bluish gray		..	5
Coal blossom, Brookville		..	4
Clay, siliceous		1	0

VANPORT LIMESTONE MEMBER

This member was first called the Ferriferous limestone because, in many localities, a very valuable deposit of iron ore rests directly upon it. In southern Ohio it was locally referred to as the Gray or Hanging Rock limestone. The term Vanport, which is now in more common use, is from Vanport, Pennsylvania, where the bed is well exposed along the cut of the Pennsylvania Railroad.

In Ohio the most extensive and persistent field of Vanport limestone extends northward from the Ohio River through western Lawrence, eastern Scioto, eastern Jackson, and western Gallia counties to central Vinton. It is here a rather pure limestone with local lenses and stringers of flint or chert in the upper portion. The bed varies from 4 to 10 feet in thickness. Throughout the central part of the State in Hocking, Perry, Muskingum, Licking, Coshocton, Holmes, Tuscarawas, and Stark counties the deposits are generally small and either decidedly shaly or flinty in character. In general shale alone marks the horizon. Flint deposits are especially conspicuous on Flint Ridge in western Muskingum and southeastern Licking counties. In Mahoning County the member again shows more characteristic properties in that it is a rather pure limestone but is patchy in development. In Columbiana County the horizon is marked by fossiliferous shale although near by at Vanport, Pennsylvania, it is again well developed. Flint is a common associate material in southern Ohio, is a prominent representative throughout central Ohio, but is nearly absent in the eastern part of the State. Aside from Flint Ridge, the deposits were probably not worked to great extent by primitive man. The member will be traced geologically across the area.

Lawrence County

In Lawrence County the Vanport member is found to some extent in Hamilton, Perry, Upper, Elizabeth, Decatur, Symmes, and Washington townships. The limestone lies about 23 feet below the Lower Kittanning coal and directly above the Clarion coal. Only locally are the deposits flinty in character.

The limestone is wanting in eastern Hamilton Township but in the western part, especially on the hills facing the Ohio River, it is represented by irregular masses and deposits of flint. In the south central part of Section 3, Hamilton Township, the following beds were exposed for measurement:

	Ft.	*In.*
Summit of ridge, elevation 850 feet	..	..
Shale, gray	5	0
Flint and ore, *Vanport*	2	0
Clay and covered	27	0

Sandstone, massive		35	0
Sandstone, with parts covered		59	0
Ore, blocky, *Upper Mercer*		..	6
Sandstone, shaly		4	0
Covered		8	0
Shale, gray		8	0
Coal, good	*Upper Mercer*	1	4
Clay, impure		..	6
Coal, good		..	8

This flint is light gray in color, porous in texture, and calcareous in composition. Thus it is of inferior grade, doubtfully usable for implements. About 10 inches of such material was observed on the ridge in the southeastern part of Section 4, Hamilton Township, and scattered blocks strewn on the surface were present elsewhere along the high ridges. In Upper and Elizabeth townships the Vanport member is limestone, well developed, and quite free from chert or flint material.

Along the headwaters of Pine Creek, near Moulton in central Decatur Township, the deposits of Vanport limestone are decidedly siliceous in the upper portion. From 1 to 3 feet of the stratum contains irregular bands of light gray flint of low grade. The following section taken at Moulton is representative:

		Ft.	*In.*
Shale, dark		5	0
Coal blossom, *Lower Kittanning*		1	0
Clay, siliceous, good		6	0
Sandstone, shale, and covered		16	0
Limestone, with wide bands of flint	*Vanport*	2	0
Limestone, gray, dense, good		3	0
Shale, dark		..	4
Coal, good	*Clarion*	..	9
Clay, impure		..	5
Coal, good		2	1

A recurrence of the flinty condition of the Vanport limestone is found along the headwaters of Brushy Fork in sections 28 and 27, Washington Township, Lawrence County. Here the upper portion is largely impure flint of a light gray color. Much material is strewn along the outcrop, some of fair quality. The geology of the deposit is shown in the record given below and taken at the head of Brushy Creek in the central part of Section 27, Washington Township.

	Ft.	*In.*
Sandstone, massive	18	0
Limestone, upper 3 feet very flinty, mainly flint on outcrop, *Vanport*	6	0
Shale, draw slate	..	5

Coal, good	Clarion	1	0
Clay, impure		..	5
Coal, good		2	0
Shale, dark		..	2
Coal, fair		..	5

Scioto County

The Vanport member is present in Scioto County in local areas in Green, Vernon, and Bloom townships. In general the member is poorly exposed. Flinty phases are present, especially in Green and Bloom townships.

In Green Township the member is traced by scattered lenses of flinty or cherty material along the ridges from the Scioto-Lawrence county line westward to about one mile west of Ohio Furnace.

In Vernon Township the deposits of Vanport limestone are found along the high ridges both east and west of Pine Creek. Flint appears very locally. In Bloom Township the member is present along the main ridges and high knobs in the southeastern and northeastern parts of the area. Along the ridges to the east and north of Bloom Furnace in sections 20 and 29 the deposits are very flinty in nature. Large blocks of such material are strewn along the outcrop. Similar conditions exist on the knobs in Section 1.

Jackson County

Throughout eastern Jackson County the Vanport member has excellent continuity, good thickness, and high quality. It is present in large or small areas in Hamilton, Jefferson, Madison, Franklin, Bloomfield, Lick, Coal, and Milton townships. In general the deposits are pure but locally flint nodules or stringers appear in the upper part of the stratum. Such flint is most abundant in Jefferson and Milton townships. A few sections are given to show the geological features.

Along the ridges both to the north and to the south of Monroe Hollow in the south central part of Jefferson Township the Vanport member is locally very siliceous in character. In places the entire bed is a light gray porous flint of poor quality. Another area showing much flinty material is the knobs north of Hewett Run in north central Jefferson Township. In most of Madison Township the limestone is exceptionally free from even nodular material. However, it is somewhat flinty near Moriah Church in Section 16. Some flint is shown north of Clay in Section 36, Franklin Township, where the following record was taken on the Albert Evans property:

		Ft.	In.
Limestone, flinty, *Vanport*		3	0
Clay shale, soft		2	0
Coal, shaly	*Clarion*	..	2
Coal, good		1	3
Clay shale		..	4½
Coal, good		1	5
Clay, with pyrite		..	1
Coal, good		..	10

The Vanport member is widely distributed in Bloomfield Township and generally of high purity and good thickness. Small pockets of flint were observed in the limestone in Section 3. Throughout southwestern and central Milton Township the deposits of this formation are commonly flinty in nature. The quantity of flint varies from a few scattered nodules in the limestone to one-half of the bed being made up of such material. Some of the flint is of fair quality but most of it is too open and porous to be fitted for working into implements. Locally the outcrops are strewn with fine and large blocks, hence such material was easily available.

Along Raccoon Creek in the vicinity of Buckeye Furnace in sections 26 and 35 the deposits are very siliceous in character, the flinty portion making up about one-half of the bed. The geological conditions are shown in the record given below and taken along the road that leads from Raccoon Creek northwest to the ridge top in central Section 26, Milton Township:

		Ft.	In.
Shale, siliceous		9	0
Coal blossom, *Upper Freeport*		1	0
Shales, pink and colored		7	0
Clay, light		1	0
Sandstone, shaly	*Upper Freeport*	1	0
Sandstone, massive		59	0
Shale and covered		10	0
Shales and sandstones		7	0
Covered		9	0
Coal blossom, *Lower Kittanning*		1	0
Clay, light, plastic, siliceous		5	0
Sandstone, shaly		24	0
Ore, block, *Ferriferous*		..	4
Limestone, very flinty	*Vanport*	2	0
Limestone, good		2	6
Coal, good	*Clarion*	1	8
Clay and bony coal		..	8
Coal, good		1	4
Clay, impure		..	2
Coal, good		1	0
Coal, bony		..	2

Clay and covered	3	0
Sandstone, massive, *Clarion*	48	0
Shales, gray	6	0
Shale, black, *Brookville* coal horizon	2	0
Covered	4	0
Level of bridge over Little Raccoon Creek, elevation 648 feet	..	..

A large area of flinty limestone is present in the west central part of Milton Township. This extends from Latrobe Furnace on the south to Wellston on the north and from the old Teays River Valley on the west to the present Little Raccoon Creek on the east. The area includes sections 29, 28, 20, 21, 19, 18, 17, 16, 15, and 8. The deposits lie close to the ridge tops at elevations varying from 800 to 850 feet. Much flint in various sized blocks is strewn along the outcrop. Some of it is of good quality, being well fitted for making implements.

Several Indian mounds are present in this area, all along the ridge tops near the flint deposits. These are located, one in central Section 32, one in the northeast corner of Section 29, one in the southeast part of Section 21, and two close together on the flat ridge in southwest Section 22. Chipping grounds were evident along the ridges, especially near the mounds. A few sections will be given to show the geology of the formation.

Just southwest of Latrobe Furnace in the northeastern part of Section 29, Milton Township, the following beds were exposed for measurement:

		Ft.	*In.*
Flint, fractured, light, fair quality	*Vanport*	1	6
Limestone, hard, gray, good		3	0
Shale, soft, dark		..	4
Shale, bony		1	1
Coal, good	*Clarion*	1	9
Coal and thin coal bands		..	8
Coal, good		1	6
Clay, with pyrite		..	1
Coal, good		..	11

Along the ridge northeast of the village of Roads in sections 17, 18, 19 and 20, flint of some grade is the dominant material on the Vanport horizon. Some of the flint is of good quality, similar to that on Flint Ridge in Licking County. Flint is generally present, but less in quantity, with the Vanport member in sections 21, 22, 15, and 8. The following record taken along the road in the southwestern corner of Section 9, Milton Township, is about representative:

	Ft.	*In.*
Shale	10	0
Ore, block, weathered, *Ferriferous*	..	4

Flint, light, irregular	*Vanport*, elevation 815 feet	1	0
Limestone, hard, gray		4	0
Shale, gray		..	9
Shale, black, fissile		1	8
Coal, good	*Clarion*	1	5
Clay and thin coal bands		..	8
Coal, good		1	4
Clay, with pyrite		..	1
Coal, good		1	3
Clay and covered		13	0
Sandstone, massive, soft, *Clarion*		14	0
Covered		12	0
Coal, weathered, cannel, *Brookville*		..	6
Clay, light, plastic		3	6

Along the headwaters of Mulga Run in sections 35 and 36, north, the Vanport member again takes on the flinty phase, locally as much as one-half the stratum is of this material. Part of the flint is of good quality. The following record taken in the northeast corner of Section 35, north, is representative of the more siliceous deposits.

		Ft.	*In.*
Sandstone, shaly		5	6
Shale, gray, siliceous		6	0
Ore, blocky, limonite, *Ferriferous*		..	4
Limestone, very flinty, ferruginous	*Vanport*	3	0
Limestone, gray, hard		3	0
Coal, good	*Clarion*	1	0
Coal, bony		..	4
Clay, impure		..	6
Coal, good		1	3
Clay, with pyrite		..	2
Coal, good		1	3

Some flint was also noticed west of this in sections 33 and 32, north, Milton Township. Most of this material varies in color from light gray to dark bluish gray and in texture from dense to open porous. The quality of the material is rather poor.

Vinton County

The northern boundary of the main field of the Vanport limestone is near the middle of Vinton County. The member is well developed in Wilkesville, Vinton, Clinton, and Elk townships, is wanting through lack of deposition in Knox and Brown townships, and is absent through the general rise of the strata in Jackson, Harrison, and Eagle townships. As a rock it may be represented by rather pure limestone, by cherty limestone, by flint or buhrstone, and by calcareous shale. In a few localities, especially near McArthur, this member is represented by irregular, bouldery masses of light-colored, cellular flint which formerly was quarried at several places and dressed into buhrstone. This flint was sufficiently good to have been used by primitive man for implements of various kinds.

The Vanport member in Wilkesville Township appears at the surface only along Raccoon Creek from Section 24 southward to Section 20 and along the lower courses of its larger western tributaries, Rockcamp, Indiancamp, and Karr runs. Usually it is a high-grade limestone but locally it assumes flinty phases. This condition is most evident along Rockcamp Run in the central part of Section 30, Wilkesville Township:

		Ft.	*In.*
Flint, light, irregular	*Vanport*	3	0
Limestone, siliceous		2	10
Clay, weathered		..	6
Flint, shaly		..	5
Shale, black, fissile		2	6
Coal, good	*Clarion*	1	2
Coal, bony		..	3
Clay, impure		..	7
Coal, good		1	2
Clay, with pyrite		..	2
Coal, good		1	2
Clay, siliceous		1	0

The Vanport member appears above drainage along all the major streams in the central and western parts of the area. The stone is of fair purity, only locally varying toward the flinty phase. The stringers of flint are not often above 1 foot in thickness.

The areas of outcrop for the Vanport member in Clinton Township are continued to the area lying east of the old valley extending from Dundas to Hamden. Near Dundas the deposits are thin, flinty, and uncertain. Some of the flint is of good quality but most of it is cellular and impure.

In Richland Township the only deposits of the Vanport member worthy of consideration are present on the main dividing ridge in sections 1 and 13. They vary in character, however, from a rather pure, gray limestone to buhrstone of the usual type. Some of the geological features are shown in the following record taken along the road in the northwestern part of Section 1, Richland Township, and in the southwestern part of Section 36, Jackson Township:

	Ft.	*In.*
Flint, cellular, light, *Vanport,* elevation 1,030 feet	1	6
Shale, black, fissile, weathered	1	6
Coal, weathered, *Clarion*	1	0

Clay, light, siliceous	4	0
Covered	28	0
Coal blossom, *Winters*	2	0
Clay and covered	3	0
Flint, black, *Zaleski*	..	7
Shale, dark gray	1	6
Coal blossom, *Ogan*	1	0
Clay, plastic, light	2	0

In Elk Township the Vanport member is widely distributed but very unsteady except in the southeastern part where limestone, flint, or fossiliferous shale is generally present on the horizon. The chief quarry area was west of McArthur.

Along the ridge in Section 32, the member is represented by local deposits of cellular flint from a few inches to more than 2 feet in thickness. Its position is 5 to 10 feet above the Clarion coal and its elevation nearly 945 feet above tide. This material was formerly gathered from the surface and quarried extensively for buhrstone along the ridges in southwestern Section 28, eastern Section 29, northeastern Section 18, southeastern Section 7, and southwestern Section 8, Elk Township. Small bodies of flint are also present in adjacent areas. At these old quarries the deposits are not now sufficiently well exposed for measurement. The usual thickness, however, appears to be not more than 3 feet. The flint masses are irregular in shape, vary greatly in texture and solidity, and shade from light to red in color. Some of the material is very open and porous whereas the best grade, formerly employed for buhrstone, is somewhat cellular but firmly bonded.

In Madison Township the Vanport member is generally absent except in the southern portion along Elk Fork and on Flat Run. Here locally the member assumes the flinty phase, from 1 to 3 feet of the upper part of the deposits being formed of such siliceous material. A few thin lenses of flint were observed in southern Swan Township.

Hocking County

In Hocking County the Vanport member is scarcely represented by either flint or limestone and only locally by fossiliferous shale or iron ore. In large areas its place is taken by sandstone and sandy shales. Small bodies of flint are found in a few places.

The record given below was taken along the ridge road, east of the forks, in the central part of Section 12, Washington Township, Hocking County:

	Ft.	*In*
Shale, gray, siliceous	5	0
Coal blossom, *Lower Kittanning*, elevation 995 feet	1	0
Clay, light, plastic	12	0
Flint, light to dark gray, 4 to 12 inches, *Vanport*	..	8

Perry County

Perry County is much like Hocking in that the Vanport member is poorly represented by either limestone or flint. Locally the horizon is well defined by iron ore in Monday Creek, Coal, and Salt Lick townships. In large areas it lacks representation.

In the vicinity of the old Baird Furnace, located in Section 14, Monday Creek Township, the Ferriferous or Baird ore rests on thin lenses of limestone or flint of the Vanport member. Such associations were also observed on the ridges north of Bessie Furnace and along the valleys near New Straitsville.

Licking County

"The flint beds of the Ferriferous [or Vanport] member in Hopewell and Franklin townships of Licking County are the largest in Ohio, and were extensively worked by the aborigines, who dug hundreds of pits along Flint Ridge in the mining of this material. The stratum was evidently worked for a long period, and the material, identified by its characteristic fossils, is widely distributed. Much of the flint chipped into arrows, knives, scrapers, etc., and found in the burial mounds and earthworks of the mound builders, as well as that similarly worked and found on the surface in this and adjoining states, is from Flint Ridge. The field is of exceptional interest both to the geologist and to the archaeologist. The outcrop measurements indicate that the light-colored bed of flint is from 1 to 10 feet in thickness, and that it averages about 5 or 6 feet. This stratum is directly bedded on the shaly limestone, the thickness of which, from surface indications, is from 5 to 20 feet, or even more. Owing to the slumping of the flint and to the nature of the covering, no good sections of the entire interval were obtained." [1]

On Flint Ridge the most western exposures are on the knobs near the western boundary of Section 20, Franklin Township, Licking County. Here the deposits are at the surface at an elevation close of 1,235 feet and are more or less bouldery in character. In the north central part of Section 11, Franklin Township, the stratum is massive in character and more uniformly bedded. A section taken along the road that leads from

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[1] Geol. Survey Ohio, Fourth Series, Bull. 21, p. 154.

Claylick Creek eastward to Flint Ridge in southeast Section 11, Franklin Township, follows:

		Ft.	In
Flint, not well exposed, elevation 1,250 feet	*Vanport*	5	0
Covered		13	0
Limestone, shaly, dark, fossiliferous		12	0
Covered		22	6
Limestone, blue, hard, *Putnam Hill*		..	6
Coal blossom, *Brookville*		..	6
Clay, light, siliceous		2	6
Sandstone, part shaly		37	0
Shale and covered		4	0
Sandstone, soft		15	0
Covered		2	8
Ore, blocky, *Lower Mercer*		..	4
Shale, dark, siliceous		1	0
Limestone, hard, dark, *Lower Mercer*		1	0

The great pits dug by primitive man for the quarrying of flint are in Hopewell Township, Licking County. Here the deposits are massive and along Flint Ridge are continuous. The flint is dense, massive, and of high quality. Flint from the western part of this field was employed extensively by the pioneer settlers for buhrstone for grinding grain. Regarding those deposits Hildreth states:[1] "Here it lies on the tops of the hills for many miles in extent, forming what is called 'Flint Ridge,' a locality well known to that region or country. In the two townships of Hopewell, [Licking and Muskingum counties] it lies on the surface in extensive masses, and has been an object of peculiar interest, both to the aboriginal and present inhabitants of the country. To the former, from the remote periods, it has furnished a valuable material for the manufacture of knives, spears and arrow heads. How extensively it has been worked for these purposes, may be imagined from the countless number of excavations and pits yet remaining, from whence they dug the quartz [flint], experience having taught them that the rock recently dug from the earth, could be split with much more freedom than that which had lain exposed to the weather. These excavations are found the whole length of its outcrop, from Jackson to Muskingum, but the most abundant on 'Flint Ridge' from its furnishing a more compact quartz [flint], and greatly diversified with rich colors. To the present (1838) inhabitants it is valuable as furnishing a fine article for mill-stones, as will be more especially noticed in the remarks on that subject.

"The buhr-stone in Muskingum [Licking also] County assumes a different aspect from that in Jackson. The color is lighter, and the cells differently formed. Instead of open fissures, the portions selected for mill-stones are filled with small, tortuous, vermicular passages, about the sixteenth of an inch in diameter, which, to the naked eye, appear to have been formed by an aquatic worm traversing the mass while in a soft and plastic state, but which, on a more minute examination with a microscope, prove to be the matrices or cells of a small, fusiform, univalve shell, of a genus very similar to *rostellaria,* but whose species is not yet determined. These, with occasional small joints of encrine, make up the great mass of minute cells which cover the face of a fresh-broken fragment of the buhrstone. The deposit here is from 8 to 9 feet in thickness."

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[1] Geol. Survey Ohio, First Annual Report, No. 1. 1838, p. 31.

Along Flint Ridge the main benches for reference are the Lower Mercer, Upper Mercer, and Putnam Hill limestones. Along the road to the "cannel coal" mine in the west central part of Hopewell Township, Licking County, the geological relations are as follows:

		Ft.	*In*
Flint, light, irregular, *Vanport*		5	0
Covered		41	0
Road forks, elevation 1,198 feet		..	..
Sandstone, light, soft		31	0
Sandstone and covered		17	0
Coal blossom, *Bedford*		..	6
Clay shale, light		1	6
Sandstone and covered		33	0
Limestone, dark, shaly, fossiliferous	*Lower Mercer*	8	9
Shale, calcareous, dark		..	3
Limestone, hard, dark gray, fossiliferous		1	4
Limestone, shaly, fossiliferous		..	6
Coal, bituminous, *Middle Mercer*		..	8
Shale, black, carbonaceous		..	10
Clay shale, light, siliceous		4	0
Coal, bony	*Flint Ridge*	..	10
Clay, dark		..	8
Coal, cannel		3	9
Shale, carbonaceous		1	4
Coal, cannel		..	10
Clay shale, siliceous		4	0

In the general area of the cross-roads much flint was gathered for shaping into buhrstones. It was worked only to a small extent by primitive man. East of this, however, to the Clark Corner cross-roads the deposits were worked to near exhaustion. On the spur of the ridge southwest of the cross-roads blocks of flint on the outcrop measure over 6 feet in thickness. The flint deposits here lie 88 feet above the base of the Lower Mercer limestone. Along the cut of the new road north of Clark Corners the flint exposed reaches 8 feet in thickness and where quarried for crushing southeast of the Corners it expands to 12 feet or more.

The flint was sampled in 1934 by Wilber Stout from a large pile quarried by Mr. Parks on Flint Ridge southeast of Clark Corners or about two and one-half miles north of Brownsville. Analyst Downs Schaaf:

Silica, SiO_2	98.93
Alumina, Al_2O_3	0.14
Ferric oxide, Fe_2O_3	0.06
Ferrous oxide, FeO	0.08
Pyrite, FeS_2	None
Magnesium oxide, MgO	0.02
Calcium oxide, CaO	0.04
Sodium oxide, Na_2O	<0.01
Potassium oxide, K_2O	<0.01
Water, hydroscopic, H_2O-	0.27
Water, combined, H_2O+	0.17
Carbon dioxide, CO_2	0.02
Titanic oxide, TiO_2	0.005
Phosphorus pentoxide, P_2O_5	<0.01
Sulphur trioxide, CO_2	None
Manganous oxide, MnO	0.01
Carbon, organic, C	0.18
Total	99.915

A photomicrograph of the Vanport flint from Flint Ridge taken from the Park's pit was made, 1937, by R. A. Schoenlaub of the State Highway Testing Laboratory.

Some of the geological features of the Vanport flint member are shown in the record given below and taken at the head of the ravine one-fourth mile northeast of the Clark Corners cross-roads:

		Ft.	*In*
Flint, light, pure, part yet exposed	*Vanport*	5	0
Limestone, gray, siliceous, fossiliferous		7	0
Covered		32	0
Sandstone, parts covered		28	0
Sandstone, massive		4	0
Shale, gray, siliceous		1	0
Sandstone, massive		23	0
Shale and shaly limestone, dark, fossiliferous	*Lower Mercer*	1	0
Limestone, siliceous, dark, fossiliferous		..	8
Shales with shaly limestone, dark, fossiliferous		5	0
Limestone, hard, gray, fossiliferous		3	6
Shale, calcareous, fossiliferous		..	2
Limestone, hard, gray, fossiliferous		1	8
Coal, hard, bony	*Middle Mercer*	..	2
Coal, good, bituminous		..	4

Small deposits of flint and limestone of the Vanport member are present on Buzzard Glory Knob and on the high points near the Fairview

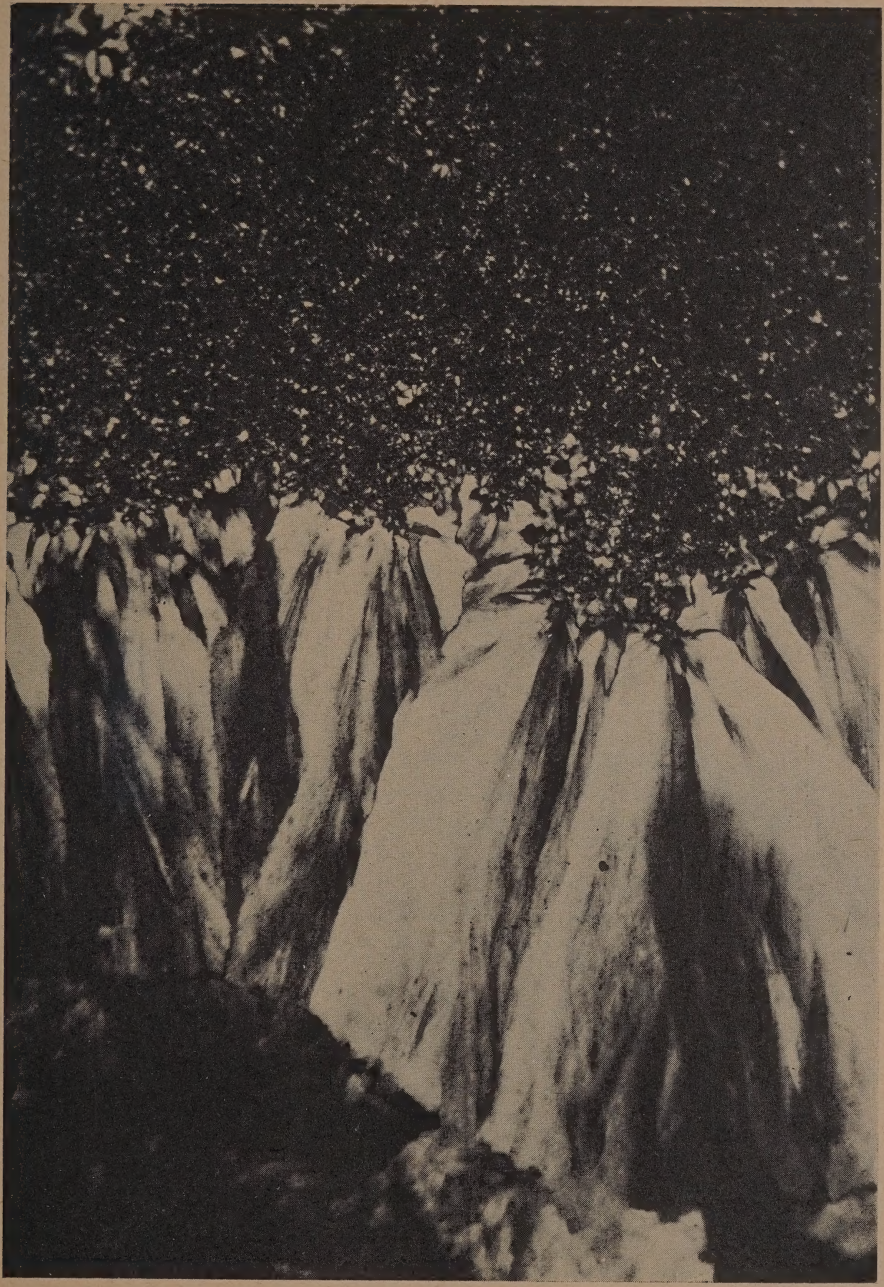

PLATE X

Photomicrograph of Vanport Flint

This photograph shows the typical structure of material from Flint Ridge. The spherulitic forms are inperfections which follow seams and fill cavities. The very fine grained material is characteristic of the bulk of the formation. It is more crystalline than the photograph indicates. Impurities in the better grades of material are insignificant. Magnification 100 diameters. Crossed nicols. N-89.

School, about one mile south of the cross-roads near the cannel coal mine.

Along Flint Ridge, about three-fourths of a mile east of Clark Corners, the flint is conspicuously banded, light gray to dark in color, and concretionary or bouldery in character. It was worked to some extent. From spalls and chips present on the surface the flint was very light in color and high in quality on the long point southeast of the Clark Corners. The pits here are the largest on Flint Ridge and thus attest to the quality of the material.

In Section 13, Hopewell Township, Licking County, the flint deposits are present along the ridge at elevations of 1,120 to 1,130 feet. Locally the flint is absent, only the limestone phase being present to mark the horizon of the Vanport member. North of the cross-roads in central Section 13 the following measurements were taken:

		Ft.	*In*
Flint, blocky, light, good	*Vanport*	5	0
Limestone, siliceous, parts covered		22	0
Covered		60	0
Coal blossom, *Upper Mercer*		..	6
Clay and covered		5	6
Limestone, shaly, very fossiliferous	*Lower Mercer*	7	0
Limestone, hard, dark gray		..	8
Shale, calcareous, fossiliferous		..	2
Limestone, hard, dark gray		1	11
Coal, bony	*Middle Mercer*	..	2
Coal, good		..	5
Sandstone, shaly		1	10
Shale, gray		1	0
Shale, dark, carbonaceous		2	8
Coal, bituminous, good	*Flint Ridge*	1	9
Shale, bony		..	9
Coal, bituminous, good		..	10

The flint deposits are not so prominent in sections 12 and 19 but appear in force in sections 11 and 20. Here the elevation of the members is not far from 1,100 feet. In the hollow just northwest of the center of Section 11, the following detailed record was secured:

		Ft.	*In*
Flint, light, good	*Vanport*	5	0
Covered		7	0
Limestone, shaly, thin to medium bedded		5	0
Shale, calcareous, fossiliferous		3	7
Limestone, shaly		..	2
Shale, calcareous, fossiliferous		5	2
Limestone, shaly		..	3
Shale, calcareous, fossiliferous		2	6
Limestone, shaly		..	2
Limestone, shaly		..	3
Shale, calcareous, fossiliferous		..	11
Limestone, shaly		..	3
Limestone, shaly		..	2
Shale, calcareous, fossiliferous		..	6
Limestone, shaly		..	3
Shale, calcareous, fossiliferous		..	9
Limestone, shaly		..	1
Shale, gray, siliceous		10	0
Covered		9	0
Sandstone, shaly		5	0
Shale, gray, siliceous		10	0
Covered		5	0
Flint, black, *Upper Mercer*		..	..

In the eastern part of Section 11, Hopewell Township, Licking County, the blocks of flint exposed along the outcrop vary from 2 to 7 feet in thickness. These deposits continue uninterrupted on eastward into northwestern Hopewell Township, Muskingum County.

Muskingum County

Throughout Muskingum County the Vanport member presents two well-defined phases, rather distinct in type and character. The upper phase is a bed of high purity flint or limestone, from one to several feet in thickness. These are correlative with the Vanport of southern Ohio in Vinton, Jackson, Scioto, and Lawrence counties. The lower phase is calcareous shale, shaly limestone, flinty limestone, or calcareous flint, or some combination of these. In a few localities both the lower and upper phases are present in the same section but at other places only one type appears. Only the deposits containing flint need to be considered here.

At the cross-roads in the east central part of Section 15, Hopewell Township, Muskingum County, 3 feet of high-grade flint is exposed along the outcrop. Many pits are also found in that general area. Here the hard flint is underlain by 19 feet of calcareous shales and shaly limestones of the lower phase. At the Drumm Hill and in the ravine to the north in the west central part of Section 14 and the east central part of Section

15, Hopewell Township, the record obtained and given below shows some of the geological features in detail:

		Ft.	In
Top of point, elevation 1,100 feet		..	..
Flint, light, hard, good, exposed	*Vanport*	2	0
Covered		1	0
Limestone, siliceous, sparingly fossiliferous		..	10
Covered		1	0
Limestone, shaly, thin-bedded, fossiliferous		15	0
Covered		6	0
Shale, gray, siliceous		19	0
Limestone, hard, blue, fossiliferous, *Putnam Hill*		1	4
Shale, dark		..	2
Coal, impure, *Brookville*		..	1
Clay, light, siliceous		3	0
Sandstone, light, clay-bonded		5	0
Clay, dark, flint	*Tionesta*	1	0
Clay, light, plastic		2	0
Covered		5	0
Shale, gray, siliceous		2	0
Covered		4	0
Flint, hard, irregular, black, *Upper Mercer*		1	0
Shale, dark		..	4
Coal, bony, cannel nature, *Bedford*		1	0
Clay, siliceous		1	8

In its extension along the ridge southeastward from the Drumm Hill towards Mt. Sterling or Hopewell Post Office the flint bed thins and becomes patchy not far south of the Wise School, about two miles north of Coaldale. A composite section taken at the Wise School and in the ravine to the north shows the following conditions:

		Ft.	In.
Shale, dark		..	..
Coal blossom, *Middle Kittanning*		3	0
Clay and covered		34	0
Flint, light, hard, good, elevation, 1,040 feet	*Vanport*	1	2
Limestone, shaly, and shale, calcareous		20	0
Shales, siliceous		6	0
Shale, gray		22	0
Ore, dark, siliceous		..	2
Shale, dark		..	10
Sandstone, light		9	0
Covered		7	0
Sandstone, shaly		1	0
Covered		10	0
Flint, irregular, black, hard, *Upper Mercer*		1	6
Coal, cannel nature	*Bedford*	..	3
Shale, dark		..	1
Coal, hard, cannel nature		1	3

The most southern exposure of the flint as a definite unit was at the head of a tributary of Poverty Run one-half mile directly east of the Wise School. The beds exposed for measurements follow:

		Ft.	*In.*
Shale, gray		10	0
Coal blossom, *Middle Kittanning*		3	0
Clay, shale, and covered		38	0
Flint, light, blocky, good	*Vanport*	3	0
Covered		7	0
Limestone, shaly, parts covered		10	0
Covered		58	0
Flint, hard, dark, irregular, *Upper Mercer*		1	1
Shale, dark		..	6
Coal, bony, *Bedford*		..	8
Clay, light, siliceous		3	6
Sandstone, part shaly		11	0
Shale, gray, siliceous		2	0
Covered		2	0
Shale, dark, tough		1	0
Limestone, blue, hard	*Lower Mercer*	1	3
Limestone, blue, hard		1	7
Coal, bony, *Middle Mercer*		..	2
Clay, light, siliceous		2	0
Shale, bluish gray		10	6
Coal, bony, *Flint Ridge*		..	1
Clay, flint, dark, siliceous		..	11
Sandstone, argillaceous, light		6	6
Covered		4	0
Shale, blue, siliceous		4	0
Covered		1	0
Shale, dark		3	0
Covered		2	0
Limestone, ferruginous, siliceous, very fossiliferous, *Boggs*		..	10

The high-grade flint of the Vanport member extends northward with some wants along the high ridge from the Drumm Hill in sections 14 and 15 to east of Cottage Hill in Section 14, Hopewell Township. Throughout this extent it was quarried by the aborigines in a small or a large way for their implements. Along the road in the east central part of Section 6, Hopewell Township, the blocks of flint along the outcrop indicate a thickness of 5 feet or more. Here the Vanport flint lies 56 feet above the black Upper Mercer flint. Along the road southwest of Cottage Hill in southwest Section 5, Hopewell Township, the true flint is represented by a thin layer less than 1 foot in thickness and present on the knob at an elevation close to 1,100 feet. Along the ridge north of the Flint Ridge School in southwestern Section 4, Hopewell Township, the flint is of excellent quality and the deposit was worked extensively. Along the ridge in the north central part of Section 4 the following beds were exposed for measurement:

		Ft.	*In.*
Flint, light, scattered blocks, slumped some	*Vanport*	3	0
Limestone, flinty, gray to dark, fossiliferous		12	0
Shale and covered		4	0
Limestone, gray, solid, rather pure, *Putnam Hill*		6	0
Clay, light, weathered, shale, and covered		10	0
Sandstone, massive		13	0

The position of the Vanport limestone with reference to the Clarion coal, only locally developed, is given in the following record taken at the mine of Porter Brothers just south of Coaldale in southwestern Hopewell Township, Muskingum County:

		Ft.	*In.*
Top of knob, elevation 1,100 feet		..	..
Sandstone, massive		17	0
Shale and covered		18	0
Coal blossom, *Middle Kittanning*		3	0
Clay, shale, and covered		26	0
Sandstone, massive		5	2
Limestone, shaly, gray, fossiliferous	*Vanport*	11	0
Limestone, hard, gray, fossiliferous		..	7
Shale, dark, calcareous, fossiliferous		..	6
Coal, good	*Clarion*	..	5
Shale, dark		..	1
Coal, bony		..	4
Coal, good		3	8
Shale, high in pyrite		..	5
Coal, good		1	8
Coal, bony		..	2
Clay, reported		5	0
Covered		14	0
Sandstone, massive		22	0
Covered		9	0
Shale, gray, siliceous		10	0
Shale, gray, soft		6	0
Coal, good, *Bedford*		1	6
Shale and covered		32	0
Limestone, gray, hard	*Lower Mercer*	..	8
Shale, calcareous		..	2
Limestone, gray, hard		1	5

"In Newton Township, Muskingum County, nodular iron ore, shaly limestone, and fossiliferous shale are locally present to mark the horizon of the Vanport limestone. In Section 20, about 1 foot of light fossiliferous flint was observed, and in sections 21 and 28 thin beds of shaly limestone are locally present."[1]

"North of the Licking River in Licking Township, the Vanport member is wanting except on the high ridges in the northeastern corner.

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[1] Geol. Survey Ohio, Fourth Series, Bull. 21, p. 151.

On the S. H. Frazier farm located about 1 mile southwest of Shannon, thick deposits of flint are present near the summit of the hill. No good measurements of the beds were obtained, but the general appearance of the rock is the same as that below the light-colored flint along the northern extension of Flint Ridge east of Cottage Hill. In fact, it appears to be only a continuation of those deposits. The flint beds on the Frazier farm were also worked by the aborigines and many pits may yet (1916) be observed. The thickness of the member appears to be between 5 and 10 feet. The upper stratum, in places at least, is a gray nodular limestone about 1 foot in thickness. Both the flint and limestone are very fossiliferous, *Fusulina* being especially abundant. These deposits lie about 85 feet above the Lower Mercer limestone, and extend northward along this ridge into Jackson and Cass townships."[1]

"In Jackson Township only the highest hills and knobs in the extreme southeastern and northeastern parts are of sufficient height to contain the Vanport member. In the southeastern part the deposits are made up of limestone or flint or both."[2]

"The Vanport member in Cass Township is best defined in the southern part along the ridge known as The Highlands and along its spurs extending southward. The deposits vary from impure flint to shaly limestone and to solid limestone; and in thickness from 1 foot or less to as much as 10 feet or more. Along the road one-half mile north of Shannon the following rocks were exposed for measurement:

		Ft.	*In*
Limestone, gray	*Vanport*	1	8
Flint, calcareous		2	0
Covered		1	10
Shales, gray		18	8
Limestone, *Putnam Hill*		1	2

"At this place the 1 foot 8 inches of gray limestone is directly and irregularly bedded on the impure flint layers and contains some flint masses. The calcareous flint is thin to medium-bedded and gray to nearly black in color. It is similar in every respect to that of the lower phase of the Vanport member on the extension of Flint Ridge, in northern Hopewell and southern Licking townships, and is evidently a correlative deposit."[2]

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[1] Geol. Survey Ohio, Fourth Series, Bull. 21, p. 157.
[2] Idem., p. 95

Coshocton County

"The Vanport member extends northward from Muskingum County into Coshocton where it is represented by scattered deposits of impure limestone and flint. At Graham Corners, in the western part of Washington Township, the following rocks were exposed for measurement:

	Ft.	*In.*
"Coal blossom, *Lower Kittanning*	1	0
Clay and covered	12	0
Shale and covered	9	0
Limestone, hard, siliceous, *Vanport*	3	0
Clay, light	5	0
Covered	33	0
Limestone, *Putnam Hill*	5	0

"About one-half mile north of Graham Corners the bed is again exposed along the road. The record follows:

		Ft.	*In.*
Flint, light gray	*Vanport*	1	2
Limestone, flinty, shaly		2	0
Clay and covered		20	0
Limestone, *Putnam Hill*		3	0

"The light flint of the Vanport member shown in the above section is strikingly similar in appearance to that so prominently developed on Flint Ridge and is evidently correlative. Further, the shaly limestone agrees in many respects with the lower phase of the Vanport deposits in Muskingum County. Similar beds were also noted north of West Bedford and in Section 3 of Bedford Township."[1]

Meyers states in regard to the Vanport member in Bedford and Jefferson townships in Coshocton County:

"The Vanport [member] is an impure limestone that varies in its composition laterally and vertically. In general the lower portion is a light gray, thin-bedded, argillaceous limestone, grading downward into a blue-gray calcareous shale, with fossils present throughout. The upper portion is often a cream-colored to buff, cherty to opalescent flint. The following record is one of the thicker but more poorly exposed sections of the Vanport that was taken along the north-south road one and one-half miles southeast of Mohawk Village and one-fourth mile north of the Jefferson-Bedford township line:

		Ft.	*In.*
Flint, in loose blocks, cream-colored, opalescent	*Vanport*	3	0
Limestone, blue-gray, argillaceous, passing downward to blue, calcareous shale		8	6
Coal blossom, *Clarion*		1	6"[2]

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[1] Geol. Survey Ohio, Fourth Series, Bull. 21, p. 159.

[2] Thesis, Ohio State University. Theodore Ralph Meyers, 1929, The Geology of Jefferson and Bedford Townships, Coshocton County, Ohio.

The lower phase of the Vanport limestone was observed along the road north of Wills Creek in the southern part of Franklin Township. The deposits were not well exposed but appeared to be 5 feet or more in thickness. Similar deposits are also locally present north of the Tuscarawas River in northeastern Coshocton County in White Eyes and Adams townships.

"The Vanport limestone has the following characteristics in a ravine from the Lafayette-White Eyes township line, up to the road forks three-eighths of a mile west-southwest of the Bowman School, in the southeast corner of White Eyes Township, Coshocton County:

		Ft.	In.
Coal blossom, *Middle Kittanning*		1	0
Shale and covered		26	4
Coal, fair, weathered, *Lower Kittanning*		2	6
Covered		16	6
Flint, quite pure, cream colored, *Vanport*, altitude 976 feet		9	8
Shale, ferruginous		15	4
Limestone, gray, *Putnam Hill*		1	4
Clay shale		..	2
Coal	*Brookville*	..	5
Clay shale		..	2
Coal		..	5
Clay and covered		6	0
Ganister, white (shaly)		21	6
Sandstone, shaly, irregular		16	1
Ore, gray-tan, dense, *Upper Mercer*		..	7
Shale, gray, (clay-like)		..	10
Shale, fissile	*Bedford*	1	0
Shale, hard, black, bone		1	2
Shale, carbonaceous		1	2
Sandstone, white, shaly		18	2
Coal, shaly, cannelloid, *Upper Mercer*		2	2
Clay, impure, and covered		3	0
Shale, white, sandy		18	0
Limestone, blue, fossiliferous, incipiently shaly, *Lower Mercer*		3	0
Clay and covered		3	0
Sandstone, mostly 1 inch to 2 inch beds		15	0"[1]

Tuscarawas County

The deposits of flint in the Vanport limestone are not especially conspicuous in Tuscarawas County as the member is only locally represented, then commonly by limestone or calcareous shale. Flinty material was observed at a few places in Salem, Jefferson, and Auburn townships.

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[1] Unpublished report on Holmes County, by George W. White, Assistant Geologist, Geological Survey of Ohio.

Holmes County

In most of Holmes County the Vanport member and also the associated Clarion coal are absent from the section. No deposits of flint were observed.

Wayne County

Conrey in his report on Wayne County failed to find the Vanport member either as limestone, flint, or fossiliferous, calcareous shale.[1]

Stark County

In the southern part of Stark County the Vanport member is absent except in small patches in Pike and Bethlehem townships where gray limestone, normal in appearance and character, appears. At Middle Branch such limestone is also worked for Portland cement. No flint was observed in the area.

Mahoning County

Limestone of high purity is also found in the Vanport deposits near the hill tops south and east of Lowellville and again north of the Mahoning River north of this place. The deposits show little or no flint.

Columbiana County

In Columbiana County the Vanport member is absent more often than present. Usually the horizon is marked by calcareous fossiliferous shale and by shaly limestone, commonly less than 1 foot in thickness. No flint was observed at any place in the area.

HAMDEN MEMBER

"The Hamden is one of the unsteady and variable members in the coal formations of Ohio. It may be represented by a regularly bedded limestone, by nodular limestone, by calcareous shale, by iron ore, or by some combination of these. It occurs more in the form of lenses of small or medium size than in that of a sheet of wide extent. The areal range of the member as now known is from Beaver County, Pennsylvania, southward to Jackson County, Ohio. In this State the material in some form on the Hamden horizon appears in local areas in Columbiana, Mahoning, Stark, Carroll, Tuscarawas, Coshocton, Muskingum, Perry, Hocking, Athens, Vinton, and Jackson counties."[2]

The nearest and only approach to true flint observed on this horizon is on the tributary of East Branch of Raccoon Creek, one and one-half miles north of Starr in south central Starr Township, Hocking County. The record taken in a ravine just west of the railroad is given below:

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[1] Geol. Survey Ohio, Fourth Series, Bull. 24.
[2] Geol. Survey Ohio, Fourth Series, Bull. 31, p. 303.

	Ft.	*In.*
Top of knob, elevation 1,000 feet	..	..
Shale and covered	32	0
Clay, dark, with small concretions of limestone and iron ore	5	0
Limestone, fresh-water, light, *Lower Freeport*	1	0
Clay shale, dark gray	2	0
Shales and covered	21	0
Coal blossom, *Middle Kittanning*	2	0
Shales and covered	25	0
Flint, light gray, 1 foot to 1 foot 6 inches thick, *Hamden*	1	0
Coal blossom, *Lower Kittanning*	2	0
Clay, light, siliceous	5	0
Shales and covered	32	0
Sandstone, shaly	5	0
Shale, gray	10	0
Shale, black, fissile	5	0
Coal, *Clarion*	1	1
Clay and covered	3	0
Sandstone, massive	14	0
Level of Hocking Valley Railroad	..	..

This flint is more a flinty ganister than a true flint, however; it is hard, dense, and somewhat vitreous. The deposit appears to be local as it was not observed elsewhere in that locality. The quality was not such as to be attractive to primitive man for the manufacture of implements.

FLINTY SANDSTONE, MAHONING MEMBER

Occasionally sandstones developed a flinty character through secondary enrichment of silica. Such deposits are usually not large and are more or less concretionary or lenticular in character. Such a condition was observed in the Mahoning sandstone in eastern Vinton County. Exposed along the ridge road in Section 36, Wilkesville Township, Vinton County, at an elevation approximating 910 feet, were irregular masses of flint and flinty sandstone, 2 feet or more in thickness. No fossils were observed in the material. A composite section taken of this locality is given below:

		Ft.	*In.*
Shale, drab		5	0
Limestone, blue, pure, fossiliferous	*Brush Creek*	..	10
Limestone, blue, very siliceous, fossiliferous		2	8
Shale, gray		6	0
Sandstone, shaly		1	0
Shale, gray, siliceous		13	0
Covered		3	0
Shale and shaly sandstone		20	0

		Ft.	*In.*
Coal, weathered, *Mason*		..	10
Clay shale, red, part covered		30	0
Flint in sandstone	*Mahoning*	2	0
Sandstone and covered		12	0
Covered, *Upper Freeport* coal in upper part of interval		30	0
Shale and sandstone		32	0
Sandstone, soft, part shaly		17	0
Shale and covered		16	0
Coal, weathered, *Middle Kittanning*		..	6

No other deposits of like material were observed in that area. Such flint or flinty sandstone is low grade and most certainly was not used by primitive man.

BRUSH CREEK LIMESTONE MEMBER

"The Brush Creek limestone, named by I. C. White, in 1878, for deposits appearing on Brush Creek, in Cranberry Township, Butler County, Pennsylvania, is a well recognized stratum in the Conemaugh formation of Ohio. It extends with some wants from Columbiana County on the north to Lawrence County on the south, but along its outcrop it shows much variation in character. The member may be represented by dark, carbonaceous shale; by this with nodules of dark to gray limestone; by dark gray limestone; by gray, calcareous shale; by gray to nearly black flint; by gray, shaly flint, and by various combinations of these. In general the most common representative is dark shale with nodular limestone in eastern Ohio and gray shale with gray to dark limestone or flint in the southern part of the State. With few exceptions in eastern Ohio the member consists of only one stratum of calcareous material but in central and southern Ohio it is normally made up of two beds of limestone or flint separated by from 10 to 30 feet of limestone or shale. This double structure is well recognized in Lawrence, Gallia, Vinton, Meigs, Athens, Perry, and Morgan counties. As indicated by the fauna, the Brush Creek member is largely of marine origin, commonly being very fossiliferous. In small areas however, the strata appear to have been deposited in brackish water. In a general way the deposits thicken in their extension southward across the State. The average measurement of the member is about 5 feet in eastern Ohio and at least 22 feet in the southern part of the field. The Brush Creek limestone is separated from the Cambridge limestone by an interval of 48 feet in eastern Ohio and by that of only 29 feet in southern Ohio. The contraction is somewhat similar with the beds lying between the Upper Freeport coal and the Brush Creek limestone, which in eastern Ohio measures on the average 96 feet and in southern Ohio 68 feet." [1]

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[1] Geol. Survey Ohio, Fourth Series, Bull. 31, pp. 357-358.

Throughout southern and central Ohio flint appears locally on this horizon, in large or small amounts and in impure or rather pure form, in Lawrence, Gallia, Meigs, Vinton, Athens, Perry, and Muskingum counties. Much of it is shaly or limy but some of it has sufficient purity for working into implements. The best grades are usually black or very dark in color. In general the deposits outcrop favorably for quarrying and much fair material is found along the outcrop in stream beds or along the hillsides. Most certainly this material was used in a small way for darts, spears, knives, etc.

The deposits will be treated in a general way. In Lawrence County the Brush Creek member locally is in the eastern half of the area. It is best represented in Symmes, Aid, Mason, and Lawrence townships, but is also present in small areas in Decatur, Elizabeth, Perry, and Windsor townships. The positions of the deposits are from 80 to 90 feet above the Upper Freeport coal and 20 to 30 feet below the Cambridge limestone. In parts of Gallia County, where characteristically developed, the member consists of two distinct units separated by 15 to 20 feet of calcareous, fossiliferous shale. In Lawrence County such units are less distinct. The whole interval usually is taken by thin to medium bedded layers of flinty limestone interbedded with shales. A few sections are given to show the general geology of the member.

In central Aid Township north of Elking Creek and one and one-half mile west of its mouth, the Brush Creek member has the following structure, thickness, and character:

		Ft.	In.
Limestone, flinty	*Brush Creek*	..	10
Shale, calcareous		..	1
Limestone, flinty, blocky		..	4
Limestone, flinty, blocky		..	8
Shale, calcareous		..	2
Limestone, flinty, blocky		..	4
Shale, calcareous		..	6
Limestone, flinty, blocky		..	6
Shale, calcareous		..	4
Limestone, flinty, blocky		..	4
Shale, calcareous		..	6
Limestone, impure		1	0
Limestone, impure		..	6
Limestone, impure		..	6
Limestone, thin-bedded, impure		..	10
Shale, calcareous, greenish tint		..	9
Limestone, impure		..	3
Shale, calcareous, greenish tint		..	5
Limestone, with a few irregular bedding planes		2	6
Limestone, shaly, nodular		1	2
Shale, gray, with three thin layers of nodular limestones		1	3
Shale, blue		1	0

At this place the top of the Brush Creek member lies about 25 feet below the Cambridge limestone, also well developed. A part of the Brush Creek material is sufficiently flinty to have been useful to primitive man for rough implements. It is hard and tough and breaks with an imperfect conchoidal fracture. The prevailing color is light gray. Other deposits in these townships are similar to the above.

The member extends eastward into Mason Township with much the same geological conditions. The following section was measured in the State Quarry at Arabia in northwestern Mason Township:[1]

		Ft.	In.
"Limestone, light brown, dense, cherty	Brush Creek	..	9
Shale		..	1½
Limestone, light brown, dense, cherty		..	4
Limestone, shaly		..	3
Shale		..	0½
Limestone, dense, cherty		..	7½
Shale		..	3½
Limestone, dense, cherty		..	8
Shale		..	3½
Limestone, dense, cherty		..	3½
Shale		..	3
Limestone, light brown, dense, cherty		..	8
Shale		..	4
Limestone, cherty		..	2
Shale		..	2½
Limestone, light brown, dense, cherty		1	1
Limestone, cherty		1	0

"An analysis of the stone from the above quarry, sampled September 8, 1939, by Julian Maxey, is as follows: Analyst Downs Schaaf.

Silica, SiO_2	52.75
Alumina, Al_2O_3	6.28
Ferric oxide, Fe_2O_3	0.59
Ferrous oxide, FeO	1.01
Pyrite, FeS_2	<0.01
Magnesium oxide, MgO	0.92
Calcium oxide, CaO	18.60
Strontium oxide, SrO	<0.01
Barium oxide, BaO	<0.01
Sodium oxide, Na_2O	0.12
Potassium oxide, K_2O	0.95
Water, hydroscopic, H_2O-	1.11
Water, combined, H_2O+	1.46
Carbon dioxide, CO_2	15.51
Titanic oxide, TiO_2	0.22
Phosphorus pentoxide, P_2O_5	0.32
Sulphur trioxide, SO_3	0.04
Manganous oxide, MnO	0.18
Carbon, organic, C	0.05
Total	100.11"

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[1] Thesis, Ohio State University, Julian Spencer Maxey, 1940, Geology of a Portion of Lawrence County, p. 39.

The flinty phase of the Brush Creek limestone is present also in southern Symmes and southeastern Decatur townships. On the divide between Slab Fork and Pine Creek, in Section 25, Decatur Township, the record given below was taken by Julian Maxey, September 22, 1939.

		Ft.	*In.*
Limestone, flinty	*Brush Creek*	..	6
Clay shale		..	1
Limestone, flinty		..	6
Clay shale		..	1
Limestone, cherty, nodular		..	2
Clay shale		..	1
Limestone		..	3
Shale, calcareous		..	2
Limestone		..	6
Clay shale		..	1
Limestone		..	3
Shale		..	2
Limestone		..	4
Clay shale		..	2
Limestone		2	4
Clay shale		..	2
Limestone		..	5
Shale and covered		..	..

The composition of the sample taken by Julian Maxey is as given below: Analyst Downs Schaaf.

Silica, SiO_2	51.20
Alumina, Al_2O_3	4.60
Ferric oxide, Fe_2O_3	0.77
Ferrous oxide, FeO	1.07
Pyrite, FeS_2	0.20
Magnesium oxide, MgO	0.75
Calcium oxide, CaO	20.71
Strontium oxide, SrO	<0.01
Barium oxide, BaO	<0.01
Sodium oxide, Na_2O	0.10
Potassium oxide, K_2O	0.74
Water, hydroscopic, H_2O-	0.97
Water, combined, H_2O+	1.06
Carbon dioxide, CO_2	17.30
Titanic oxide, TiO_2	0.14
Phosphorus pentoxide, P_2O_5	0.25
Sulphur trioxide, SO_3	0.02
Manganous oxide, MnO	0.15
Carbon, organic, C	0.04
Total	100.07

In the vicinity of Waterloo in Symmes Township, Lawrence County, and Walnut Township, Gallia County, the Brush Creek member maintains excellent continuity, is from 5 to 15 feet in thickness, and contains sufficient excess siliceous matter to be flinty in character.

In Gallia County the deposits of Brush Creek limestone are found chiefly in Walnut, Perry, Green, Raccoon, Springfield, Huntington, and Morgan townships. In Walnut and Perry townships the limestone is flinty in character but north of this it has higher purity or is thin and shaly. The siliceous character of the material and the structure of the member are shown in the following record taken north of the mouth of Fork Creek, west of Salome Church, in the northwestern part of Section 23, Perry Township, Gallia County:

		Ft.	*In.*
Limestone, dark gray, *Cambridge*		2	0
Clay shales, red, parts covered		13	0
Shales and covered		11	0
Clay shales, red, parts covered		6	0
Shales, gray, siliceous		6	0
Shales, siliceous, with nodules of fossiliferous limestone	*Brush Creek*	4	0
Limestone, fossiliferous, flinty		4	6
Shales, calcareous, parts covered		13	0
Limestone, fossiliferous, siliceous		2	0

In Meigs County the Brush Creek deposits are confined to western Salem and western Columbia townships. Condit states:[1] "The Brush Creek limestones ordinarily consist of two parts, separated by about 20 feet of shale, which is also fossiliferous in some localities, giving a total thickness of as much as 35 feet of marine beds. From this it is evident that the upper and lower limestones were formed in the same sea. In many localities sandy strata occupy the place of one or both of the beds. Probably this means that the sea, in which the limestones were forming, was reached by rivers whose sediments were deposited in delta fashion, locally preventing the growth of marine organisms. The limestones vary greatly in appearance. In the northern part of the county they are cherty beds each about 5 feet thick, but southward they change to impure limestones of a rusty-gray color."

The following section, by Condit, was taken in the south central part of Section 23, Columbia Township, Meigs County, and in the hollow to the west:[2]

---

[1] Geol. Survey Ohio. Fourth Series, Bull. 17, p. 94.
[2] Idem., p. 95.

		Ft.	In.
“Shale, sandy, unmeasured		..	..
Limestone, *Ames* or *‘Crinoidal’*, nodular, ferruginous		2	0
Shale		15	0
Clay, *Round Knob*, red, with a layer of white, non-fossiliferous limestone		25	0
Interval, not exposed		58	0
Brush Creek horizon	Cherty, impure, fossiliferous limestone in a number of layers	4	0
	Interval	18	0
	Cherty, impure, fossiliferous limestone in several layers	6	0
Sandstone, unmeasured.			

In the northern part of Columbia Township about one and one-half miles southwest of Mt. Blanco, the following strata were exposed along the road south of the center of Section 29:

	Ft.	In.
Limestone, part flinty, gray, *Upper Brush Creek*	2	6
Shale and covered	28	0
Sandstone, shaly	2	0
Limestone, fossiliferous, gray, part flinty, *Lower Brush Creek*, elevation 800 feet	5	0

The following photomicrograph was taken in 1936, by R. A. Schoenlaub of the State Highway Testing Laboratory, of flint from the Brush Creek member in Meigs County.

Vinton County

“In the extension of the Brush Creek limestone across the State only the eastern part of Vinton County lies within the belt of outcrop. The main body passes to the east of this through Athens and Meigs counties. In the area under consideration such deposits are found along the ridges in eastern Brown, eastern Madison, Knox, eastern Vinton, and Wilkesville townships. Although the Brush Creek member is the most definite stratigraphic unit in the Conemaugh formation of Vinton County, it is not a persistent deposit and undergoes some changes in character. It is wanting through lack of development and also through replacements by sandstone. This applies to both the lower and the upper benches of the member which normally are separated by about 27 feet of shale and sandstone. The lower stratum consists usually of dark, fossiliferous shale, of this with hard limestone, and of gray to dark flint; whereas the upper one is made up of gray, siliceous limestone or of gray to nearly black flint. From many measurements the average thickness of the lower bench is 11 inches and that of the upper layer 2 feet.”[1]

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[1] Geol. Survey Ohio, Fourth Series, Bull. 31, pp. 358-359.

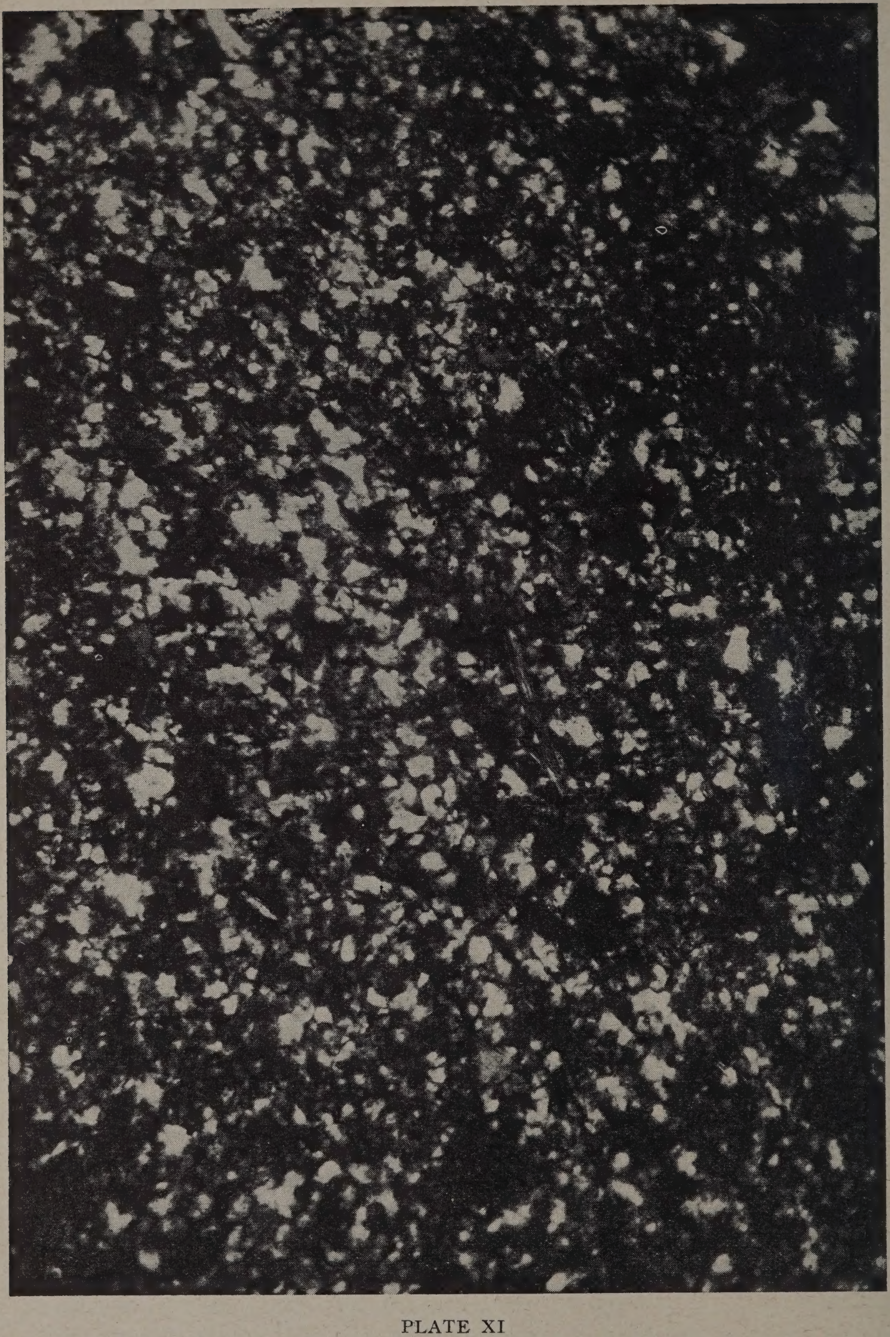

PLATE XI

Photomicrograph of Brush Creek Chert

The Brush Creek limestone occasionally contains chert in Southeastern Ohio. This photograph represents material from the Northeastern corner of Meigs County. The chert is coarse in structure with isotropic material surrounding siliceous spherulites. It contains also mica, quartz and limonite. Magnification 100 diameters. Crossed nicols. No. 92.

"The Brush Creek member in Madison Township, Vinton County, is confined entirely to the high ridges in the eastern part. Where the upper stratum makes its appearance it is commonly a hard flint, dark gray to nearly black in color. Locally also the lower bench tends towards the flinty phase, but commonly it is either limestone or fossiliferous shale. In the northern part of the township the most western deposit observed is on the knob in the southeastern part of Section 30. The material is a ferruginous chert lying 1,060 feet above tide and about 50 feet above the Freeport coal. At the forks of the road in the northeastern part of Section 24, the upper stratum is represented by approximately 2 feet of shaly limestone and black flint, the latter hard, brittle, and lustrous. Similar deposits were observed along the ridges in the northern and eastern parts of Section 18 where in a few places the bed thickens to 2 feet 6 inches and changes from the calcareous phase to nearly pure flint. The descent above tide is from 1,030 to 1,000 feet. The areas of such material are small in Section 17. The most conspicuous outcrop in Section 23 is near the school house, 1,080 feet above tide, in the northwestern part of the area. Some of the stratigraphic features are shown in the following record taken along the road in the central part of Section 16, Madison Township, Vinton County:

	Ft.	*In.*
"Conemaugh formation		
Flint, light to gray, upper bench of *Brush Creek*	2	2
Shale and covered	16	6
Coal blossom, *Brush Creek*	..	6
Shale and shaly sandstone	27	0
Limestone, shaly, very fossiliferous, lower bench of *Brush Creek*	1	2
Shale and covered	16	10
Coal and coaly shale, *Mason*	2	0
Clay and clay shale	5	4
Coal, *Mahoning*	..	6
Clay and shale	8	2
Shale and shaly sandstone	4	0
Ore, irregular	..	3
Allegheny formation		
Coal, smut, *Upper Freeport*	..	1
Clay, impure	..	11
Covered	10	9
Sandstone, shaly	4	0
Shale and covered	10	0
Sandstone, massive, *Upper and Lower Freeport*	58	0
Shale and covered	6	0
Coal blossom, *Middle Kittanning*	1	0"[1]

"All the main ridges in Knox Township, Vinton County, have sufficient height to contain deposits of Brush Creek limestone. The altitude of the member is 990 feet in the west central part of Section 12, 850 feet in the southeast corner of Section 30, 968 feet in the southwestern part of Section 7, and 820 feet in the east central part of Section 25. The lower stratum is usually shaly or limy in character, whereas the upper one is commonly flinty. The following record taken in the east central part of Section 27 is approximately representative:

---

[1] Geol. Survey Ohio, Fourth Series, Bull. 31, pp. 360-361.

	Ft.	*In.*
"Shale, gray, parts covered	33	0
Shale, red	2	0
Coal blossom, *Wilgus*	..	6
Clay and covered	9	6
Sandstone, shaly	4	0
Clay shale, red, parts covered	15	0
Sandstone, massive	6	0
Flint, light to gray	1	3
upper bench of *Brush Creek*		
Flint, shaly, gray	1	9
Shale, gray, soft	5	0
Covered	6	0
Shale, gray	16	0
Covered	3	0
Limestone, gray, fossiliferous, lower bench of *Brush Creek*	1	3
Coal and coaly shale, *Mason*	1	0
Shale and shaly sandstone	4	0
Sandstone, massive, *Mahoning*	60	0"[1]

The deposits of the Brush Creek member in Vinton Township, Vinton County, are confined to the main ridges in the eastern part and to a few high knobs in the central part. Its thickness varies from 1 to 5 feet and its composition changes from an impure limestone to dense, hard flint.

Athens County

In Athens County the Brush Creek member is made up ordinarily of two distinct layers separated by 15 to 25 feet of shale and shaly sandstone. The deposits are uncertain, the upper layer being more persistent than the lower one. Such deposits are represented in Lee, Waterloo, York, Dover, and Trimble townships but the flinty phases are confined largely to Lee Township. Such deposits are especially conspicuous along Flat Run southwest of Albany and along Leading Creek south of this village. The following section taken on a northern tributary of Flat Run, about two and one-half miles east of Bolins Mills, shows the general geology of the member:

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[1] Geol. Survey Ohio, Fourth Series, Bull. 31, 361-362.

	Ft.	In.
Road intersection elevation 971 feet	..	..
Clay, shale, and covered	7	0
Sandstone, soft, massive	8	0
Clay, light, plastic	2	0
Shale and covered	18	0
Sandstone, massive	7	0
Shale, gray	1	0
Flint, gray to dark, upper bench of *Brush Creek*	3	6
Covered	10	0
Shale, gray, siliceous	5	0
Covered	4	0
Shale, gray	5	0
Covered	2	0
Limestone, gray, fossiliferous, lower bench of *Brush Creek*	..	8
Shale, gray	3	0
Coal, shaly, *Mason*	..	2
Covered	14	0
Sandstone, massive, soft, *Upper Mahoning*	10	0

Other sections taken in this area show from 3 to 4 feet of flint in the upper bench of the Brush Creek member. In the northern part of Lee Township the deposits are more uncertain and usually more calcareous in composition. This condition is shown in the record given below and taken along the road in the southeastern part of Section 23, Lee Township, Athens County:

		Ft.	In.
Shale, gray, siliceous		20	0
Limestone, sandy, flinty	upper bench of *Brush Creek*	1	3
Shale, gray, calcareous		1	8
Limestone, shaly		..	4
Shale, gray, calcareous		2	6
Limestone, flinty		2	2
Shale and covered		18	0
Coal blossom, *Mason*		1	0
Shales and covered		53	0
Shale, gray		10	0
Sandstone, massive, soft, *Mahoning*		7	0
Shale, siliceous		5	6
Coal blossom, *Upper Freeport*, elevation 740 ft.		1	0
Clay, impure		3	6
Sandstone, shaly		3	0

Somewhat similar deposits are found near New Marshfield in Waterloo Township and locally in York, Dover, and Trimble townships.

Perry County

In Perry County the Brush Creek member is locally present in Monroe, Moxahala, and Bearfield townships. In general the deposits consist of impure limestone and calcareous shale or this with some cherty material. The conditions are much the same in western Morgan County where the member is rather steady in Deerfield and York townships.

Muskingum County

In the southern part of Muskingum County the Brush Creek member, although varying greatly in structure, thickness, and character, is moderately persistent; but in the northern part of the county it is absent except in one locality where the horizon is marked by dark fossiliferous shale. This limestone is always impure but only locally flinty in character. This condition is shown in the record given below and taken southwest of the central part of Section 17, Brush Creek Township, Muskingum County:

	Ft.	*In.*
Shale, gray, fossiliferous, *Portersville*	5	0
Coal, good, *Anderson*	1	5
Clay, siliceous, impure	3	0
Limestone, light to dark gray, fossiliferous, *Cambridge*	2	0
Shales and covered	45	0
Limestone, dark gray, fossiliferous, interbedded with shales, upper division of *Brush Creek*	3	0
Shales and covered	14	0
Limestone, dark gray, fossiliferous, flinty, lower division of *Brush Creek*	6	0
Covered	3	0
Level of Brush Creek.		

The Brush Creek member is present also in Guernsey, Harrison, Tuscarawas, Carroll, Columbiana, and Jefferson counties. In parts of this field the formation is absent through lack of development and through replacement by sandstone. Where present the common representation is dark fissile shale or this with bouldery masses of limestone. Such deposits are free from flint or chert.

CAMBRIDGE LIMESTONE

"The Cambridge limestone, named by Prof. E. B. Andrews from exposures near Cambridge, Guernsey County, is of wide extent in Ohio as it extends from Jefferson and Columbiana counties on the east to Lawrence County on the south. Along this belt, however, many wants occur over large areas and many variations are noticed in both the thickness of the bed and in the character of the material. It changes from a persistent, uniformly-bedded limestone in southern Ohio to a nodular, fitful, and inconstant stratum in central and eastern Ohio. In composition it changes from a rather pure limestone of a dark gray color to cherty limestone of a yellowish tint or to a porous ferruginous material of a rusty appearance. In places calcareous, fossiliferous shale is also associated with the limestone."[1]

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[1] Geol. Survey Ohio, Fourth Series, Bull. 21, p. 238.

In this State the Cambridge limestone only locally assumes a cherty or flinty phase. Under such conditions the deposits contain scattered nodules or even small lenses of low grade flint. Such matter is most conspicuous in small areas in Lawrence, Gallia, and Muskingum counties. A few sections will be given to show this condition and the general geology of the formation.

In Lawrence County the Cambridge limestone is exceptionally well developed and commonly of high purity. The cherty matter is generally small in quantity. The following section was measured in the northwest quarter of the southeast quarter of Section 7, Mason Township, southeast of Arabia:[1]

		Ft.	*In.*
"Shale		3	10
Limestone, in one bed, gray, non-crystalline, fossiliferous	*Cambridge*	1	8
Clay shale		..	2
Limestone, in one bed, gray, non-crystalline, dense, fossiliferous		1	8
Clay shale		..	2½
Limestone, flinty		..	2
Clay		..	2
Limestone, in one bed, gray, non-crystalline, dense, fossiliferous		1	5"

The Cambridge member shows such impurities in parts of Raccoon and Greenfield townships, Gallia County. The composite record given below was taken just east of the White School in the southwestern part of Section 32, Raccoon Township, Gallia County.

	Ft.	*In.*
Shales	20	0
Limestone, some scattered flint nodules, gray, dense, *Cambridge*	2	0
Shales and covered	10	0
Sandstone, soft, massive	48	0
Covered	9	0
Coal blossom, *Mason*	1	0
Clay shales and covered	6	0
Sandstone, shaly	17	0
Sandstone, coarse-grained	11	0
Clay, light and red mottled	6	0
Shale and shaly sandstone	16	0
Coal smut, *Upper Freeport*	..	1
Clay, dark, siliceous	2	0

The Cambridge limestone is also flinty in character on Sand Fork in Walnut Township and near Mt. Nebo Church in Perry Township, Gallia County.

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[1] Thesis, Ohio State University, 1940, Geology of a portion of Lawrence County, Julian Spencer Maxey, pp. 43 and 44.

This formation is generally thin and pure in Meigs, Athens, and Perry counties. In Muskingum County the member is uncertain in distribution, lenticular in character, and locally cherty in composition. A composite section taken just east of New Concord is given below:[1]

	Ft.	In.
"Limestone, *Ames*	1	0
Covered	7	0
Sandstone, soft	30	0
Shale and covered	37	0
Coal blossom, *Anderson*	1	0
Clay and covered	10	0
Limestone, flinty, siliceous, fossiliferous, *Cambridge*	10	0
Clay, hard, with nodules of limestone	5	0
Shale, gray	3	0

AMES LIMESTONE

The Ames limestone is of marine origin as is shown by the abundance of fossils. With some wants it crosses the State from Columbiana County on the east to Lawrence County on the south. No flint or chert was noticed or is recorded in this formation throughout the field.

SKELLEY LIMESTONE

This is the youngest of the truly marine members in the Conemaugh series or in the Pennsylvanian system. It is only locally present and then as impure limestone usually dark in color and ferruginous in character. The deposits observed are without flint.

FRESH-WATER LIMESTONE

Throughout the great series of fresh-water limestones in the Allegheny, Conemaugh, and Monongahela series in the Pennsylvanian system and in the Washington and Greene series of the Permian system, true flint or even chert is not recorded. In Ohio the flint as a component of the carbonate rocks belongs entirely in the marine formations.

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[1] Geol. Survey Ohio, Fourth Series, Bull. 21, p. 240.

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